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PROCEEDINGS OF THE NATIONAL CONFERENCE ON SOLID WASTES MANAGEMENT, HELD AT UNIVERSITY OF CALIFORNIA, ON APRIL 4 AND 5, 1966

California University

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SOLID WASTES MANAGEMENT

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PROCEEDINGS OF THE NATIONAL CONFERENCE

University of California

Davis Campus - Freeborn Hall

April 4 and 5, 1966

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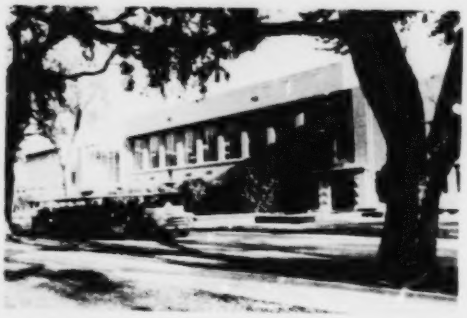

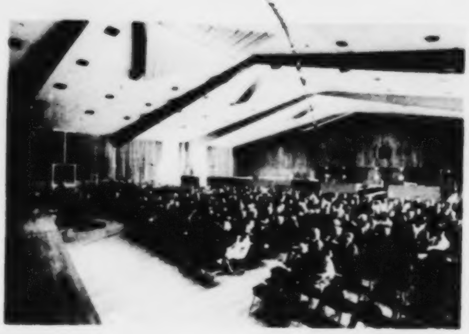

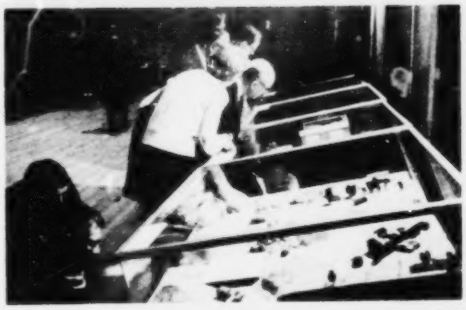

TRANSFER STATION BUILDING

CONTENTS

Foreword 1

WELCOME AND BEST WISHES
E. M. Mrak 3

GREETINGS FROM GOVERNOR BROWN OF CALIFORNIA
Paul D. Ward 7

THE PROBLEM IN PERSPECTIVE
P. H. McGauhey 11

DISCUSSION--THE PROBLEM IN PERSPECTIVE
F. R. Bowerman 23

THE PROBLEM IN DETAIL
J. H. Hickey 35

SYSTEMS ANALYSIS--A GENERALIZED APPROACH TO TECHNOLOGY
John A. Logan 45

UNDERSTANDING THIS NEW APPROACH
A. A. Brown 55

APPLICATION OF THE APPROACH, The California Waste Management Study
Thomas P. Jackson 63

THERE HAS TO BE A PONY SOMEPLACE
J. L. McDonald 91

MANAGING SOLID WASTES FOR A BETTER ENVIRONMENT
W. E. Gilbertson 95

LEGAL FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED
INTO A MANAGEMENT-SCIENCE APPROACH
J. A. Nejedly 103

ENGINEERING FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE
INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH
R. F. Weston 111

PLANNING FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE
INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH
R. L. Williams 119

POLITICAL FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE
INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH
J. L. Witherspoon 129

BUSINESS FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE
INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH
A. R. Balden 135

REFUSE INDUSTRY FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH
J. Vanderveld, Jr. 145

GOVERNMENT FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH
R. J. Black 151

ONE COMMUNITY'S SUCCESS
F. R. Cheek 161

LOS ANGELES COUNTY ACTIVITIES IN REFUSE DISPOSAL
F. R. Bowerman 169

SOLID-WASTES RESEARCH USING MANAGEMENT SCIENCE
W. L. Swager 175

COORDINATING MANAGEMENT SCIENCE WITH OTHER SOLID-WASTES RESEARCH
S. A. Hart 185

THE FUTURE
Frank M. Stead 193

List of Registrants 201

FOREWORD

These proceedings cover the second of a series of national conferences, relating specifically to solid wastes, supported by grants from the Public Health Service. The first, held in Chicago in December 1963, was entitled "National Conference on Solid Wastes Research." It stressed the needs for research on various aspects of the solid-wastes problem and had the effect of catalyzing research which is presently under way. Equally important, it revived professional interest in a persistently vexatious problem--an interest which has contributed greatly to mounting public and political interest, now being reflected in a forward-looking program of wastes legislation. It was this public awakening to the solid-wastes problem that created a climate in which it seemed timely and appropriate to hold a second national conference. The idea of a conference on solid-wastes management was made particularly timely in California in November 1964, when Governor Edmund G. Brown invited bids from the aerospace industry for investigations into the applicability of systems analysis to state problems. The aerospace industry had been using various techniques of management science in design and development of the nation's space program; it seemed appropriate to determine whether these same techniques were applicable to more earthly problems. Requests for study were in the fields of transport, penal programs, gathering and storing data for state government, and wastes management.

The waste management study was awarded to the Aerojet General Corporation. That company was asked to appraise the needs for a statewide waste management system for California for the next thirty years, and to recommend an implementation procedure. The contract ran from January 1, 1965, to August 1, 1965. In the course of the Aerojet study, communications between sanitary engineers and representatives of the aerospace industry led to an interest in and appreciation of the role that systems analysis might play in solving the wastes problem. Thus was born the theme of this conference.

In developing the conference, it was immediately evident that the problem of solid wastes must be viewed in all its many facets: engineering, legal, political, economic and business, regulatory, health, and sociological. The interaction of these forces is the basis of the management of solid wastes. Systems analysis, as a method of coordinating and of evaluating interactions and developing an optimum program, seemed worthy of study.

It was expected neither that participants in the conference be systems analysts nor that the conference would make them such. Instead, it was intended that engineers, health officials, public administrators, planners, scientists, and researchers of our nation explore how systems analysis might be brought to bear upon their own activities in solid-waste management problems.

The proceedings presented here record the principal deliberations of the Conference.

S. A. Hart
P. H. McGauhey

WELCOME AND BEST WISHES

E. M. Mrak

Chancellor
University of California
Davis, California

Dr. Emil M. Mrak is a renowned food scientist turned campus administrator. He formerly did research on the preservation of foods and retains his title of Professor of Food Technology. In 1957 he was president of the Institute of Food Technologists.

Dr. Mrak was elevated to the chancellorship of the Davis Campus in July 1959, and is responsible for all campus business--not the least of which is the management of the campus' own wastes.

Welcome and best wishes. I want to tell you we're very grateful you're here, and I hope that your visit is profitable and enjoyable.

I can tell you that, here at Davis, we know first-hand how important this problem is. I'd like to share with you just a few of the experiences I've had since I've been on this campus. I came here in 1951 from Berkeley, and was chairman of the Food Technology Department until I became Chancellor, in 1959. While still in food technology, I went out to our pilot plant one day and couldn't look out of the windows--they were covered with flies. So I wrote a letter to Chancellor Freeborn and said, "I want screens that are going to cost $30,000." And he said, "You can't have 'em."

"We've got flies," I said.

Well, he was an entomologist, and advised me "to find out where they're coming from." We found that they came out of garbage cans for solids behind the School of Veterinary Medicine, and the solution was proper manure management. So they burned their solids more frequently and cleaned their cans--and we got rid of that problem.

Then, about a year later the flies were back again. I found that the Department of Agricultural Engineering was carrying on experiments with animal waste. Once you know the source, you can take control measures, and so we got rid of that problem. But it wasn't very long before we had the problem back with us, and this time it was traced to chicken manure from the Poultry Department. So, once again, I wanted screens, and the Chancellor said, "You don't need screens; all we need to do is spread this manure out to dry." That was fine, but some of the people didn't do a good job--so the Chancellor appointed a committee on flies. The committee took care of things until the rains came, and then the maggots got in the material again, and away we went--we had flies again.

Well, this indirect effect is what I was impressed with, but it didn't stop there. In fact, this problem is with us even now. We have pigs on the campus, and we have south winds. The pigs have been here for years, and so have the south winds. The pigs are happy, but people have moved in to the north side of the campus, and the people don't like it--they are unhappy. They don't like pigs; they don't like their waste and the odors it brings. So the question is: What to do? Do we move the pigs out? If so, how long before the people who move around the campus are going to move in on them? No one has solved this problem.

That isn't all. This county is a tomato bowl, one of the most important tomato producing areas in the country, if not in the world. We did not have very serious problems with the tomatoes, or with the Drosophila fruit flies they bring, until growers started mechanizing. The mechanical harvester discards a lot of tomatoes and mashes up the vines, creating an environment favorable to the production of fruit flies. But the tomato waste problem doesn't stop there: it also increases thermophilic spoilage in canned tomatoes. The canners ask, "Why are we getting 'flat sours'?" The answer is that we're plowing a lot of the solid waste into the ground, which increases the population of thermophiles, and then we get spoilage. If we pressure-cook the tomatoes, the product is changed and is more costly.

The mechanical harvester has brought on another problem. When we harvest mechanically, we bring dust and dirt and solid waste into the canneries. On the weekends, the canners clean out all their sumps, and this material goes into the city sewers, which are too level. The sewers clog, and the city fathers wonder what's happened all of a sudden. As I've said many times in these areas of agriculture, every time we solve one problem we create about five new ones.

The most recent experience that has bothered me is open-pit burning. The question is, "What else can we do?" At one time the Davis Campus, with more than 3,000 acres of land, had areas where we could practice open-pit burning and no one would worry about it. However, people have moved in around the campus, and they don't like the smoke or the pits. If we move to the south side of the campus, we're near the golden fields of grain, with the chance of sparks flying over and setting fire. In another area we now have the Atomic Energy Commission dog colony, and the people operating the facility say that dogs don't like open-pit burning and smoke, so we're in trouble there. Finally, our really remote area is near a new six-lane highway, and I know that smoke can cause wrecks and pits are unsightly. Furthermore, considering President and Mrs. Johnson's views on highway beautification, I'm afraid to have the open pits near the highway. So what does a Chancellor do? Well, he seeks advice from a committee, and a committee advises him to bring in an expert; so we brought in some experts, and the report was rather interesting.

The report says that by the year 2000 we'll have enough solid waste on our campus to cover it seven feet deep if we don't dispose of it all the time. Well, there was some consolation in the picture, because the report was referring just to the central campus of some 700 acres, whereas if we spread the wastes over the entire 3700 acres they would be only a foot deep. Of course I hunted for their recommendation, and it turned out to be sanitary landfilling--which we have known about for many years. We have made but little real progress; I hope that all the wisdom that we have here will find a way to help me; I really do.

However, I would say on the positive side that we do have talent here, and I hope they'll work on it. I know there are people who can work together. We have a College of Engineering with professors in environment engineering and agricultural engineering; they have been working in wastes management for many years. The Department of Food Science and Technology is concerned about the wastes produced by food processing. We have a Food Protection and Toxicology Center, concerned with residues of waste and bacteria and other things on foods. And, believe it or not, we have people in the new School of Law who are very much interested in the legal aspects of this problem. Finally, we have a new School of Medicine, and the people in this school are interested.

We have facilities--we have all the animals and all the wastes we want to work with. We have a water lab, and hope to expand it. We even have people who are very interested in bees and their welfare, and what the residues of agriculture may do to them.

With all this, and with this conference you are now about to start, we should learn something, and I hope you'll come up with some answers for us.

GREETINGS FROM GOVERNOR BROWN OF CALIFORNIA

Paul D. Ward

Administrator
Health and Welfare Agency
State of California
Sacramento, California

Mr. Ward has been an administrative assistant to a Congressman, and a consultant to the California Senate, Committee on Governmental Administration. In 1961 he was appointed Legislative Secretary by Governor Brown, and in 1964 was appointed Administrator of the Health and Welfare Agency.

It seems to me that there is one great conclusion that you can draw from the Chancellor's remarks this morning, and that is that the trouble with our community and the world today is people. Perhaps what we need is a crash program in family planning. We have been attempting to lay out the problem of agency organization for effective waste management for a long, long time, with regard not only to solid wastes but to gases and environment in general; and we've come to the conclusion that there are so many governmental agencies involved and such a great need for a top-level organization to solve this problem that, despite the fact that agencies have been coordinated on some levels, much more is yet to be done. I want to point out that my particular agency in government is concerned with the health aspects of this problem.

I am here to deliver the statement that the Governor wished to be made this morning. On behalf of Governor Brown, I would like to open this National Conference on Solid Wastes Management and bring you his best wishes for a successful workshop. Governor Brown has asked me to emphasize his interest in this conference and his hope that from it will emerge creative ideas for waste management, not only in California but throughout the country. The Governor's statement is as follows:

"Never before in our history has interest in the field of waste management been so high. The recent passage of the Water Quality Control Act of 1965, the Motor Vehicle Air Pollution Control Act, and the Solid Wastes Disposal Act attest eloquently to the deep concern of Congress for this problem. The publishing of the brilliant and challenging report of the Environmental Pollution Panel of the President's Science Advisory Committee graphically depicts the equally deep concern of the National administration in the subject. But the federal government is not terminating its activities with reports and legislation. It has embarked upon a program of financial assistance for waste management that will undoubtedly exceed ten billion dollars before it runs its course.

"State and local interest, public and private, has not been idle. In January 1965 the State of California entered into four contracts with Aerospace Industry of California to apply the techniques of systems engineering to problems of state government. One of these problems was waste management, and we are gratified that that report by Aerojet-General Corporation will be the subject of penetrating analysis at this very conference.

"Other states have been equally active. What is the explanation for this sudden surge of interest in waste management? I think the answer is obvious. We are on a collision course with disaster unless we completely revolutionize, in a few years, patterns which have undergone relatively little change in the last three decades. Unless we act with all possible speed to put our waste management practices in order, we face the bleak prospect of sharply rising cost and sharply declining levels of the environmental quality. Neither our traditional patterns nor our traditional attitudes towards waste management will serve any longer. We have reached the point where man's environment is completely at the mercy of man. He may run it in a state of order and efficiency or run it in a state of anarchy, leading to chaos; but run it he will. The heritage of blue skies, green sparkling water, and green orderly countryside that you and I cherish as boyhood memories and still enjoy may never be known by our grandchildren unless we have the imagination and courage to move boldly into programs of environmental management that introduce a whole new set of principles into our political and social system. As you make your choice, I urge you to think not so much in terms of today but, instead, of the verdict of your professional colleagues of the year 2000, when they review the decisions you will reach at this conference."

And now, on behalf of the Governor I do welcome you here. I welcome to our state those of you who are from outside of California. I think that you will find our problem of tremendous magnitude when you look at our growth. I know that those of you who are from California fully appreciate this, and we earnestly hope that from this conference will come some new and vital ideas that will lead us in this regard in the future.

THE PROBLEM IN PERSPECTIVE

P. H. McGauhey

Director, Sanitary Engineering Research Laboratory
University of California
Berkeley, California

Professor McGauhey has been very active in the sanitary engineering profession for forty years. He has been a professor and research engineer at Virginia Polytechnic Institute, the University of Southern California, and the University of California. He has been director of the U. C. Sanitary Engineering Research Laboratory since 1957, and was associate director for six years preceding that. He is co-principal investigator on the U. S. Public Health Service grant that provided partial support for this conference.

Professor McGauhey was recovering from surgery at the time of the conference. His prepared paper was paraphrased by Mr. Frank Bowerman. That discussion follows this prepared presentation.

Introduction

As I approach the task of setting forth the age-old problem of solid-wastes management in its 1965 perspective so that we may consider some newer and more effective ways of attacking it, I am increasingly persuaded that the very first deterrent to effective solutions is an unresolved problem of perspective. Yielding to the human instinct to move up a little closer when one cannot see well, technical people have tended to concentrate on details of municipal waste disposal and so become outflanked and

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enveloped by other aspects of the solid-wastes problem. Conversely, public officials, planners, and administrators have tended to leave the theater entirely, or to rely on pious "thou shalt nots" which reflect the public's impatience with the result of its own untidy activities, coupled with its unreasoned longing to live the comfortable urban life in a romanticized wilderness. Thus, neither the technical nor the political leaders of the community have had an optimum perspective of the solid-wastes problem.

Basic Aspects of the Problem

Only quite recently have we begun to recognize that the fundamental factors underlying problems in solid-wastes management range from the structure of the modern community and the cultural attitudes of its citizens, to considerations of technology, economics, and resources utilization. The interrelationship of these factors and the manner in which they lead to problems of environmental control are complex. Nevertheless, the factors themselves are sufficiently well understood that it should be possible to organize a program for attacking urgent problems in solid-wastes management. As a background to a consideration of such a program I should like to summarize what I consider some of the most basic aspects of the solid-wastes management problem.

Urbanization

The rapid spread of cities, popularly known as "urban sprawl," which followed World War II is widely recognized as having revolutionized our concepts of urban life. Less well understood, however, is its effect in expanding the problem of solid-wastes management to areawide proportions beyond the resolving power of any one of the myriad separate jurisdictions that make up the overall community. Particularly in areas where an explosive increase in population has had a maximum impact, of which California is a notable example, urbanization has progressed beyond the limits of cities and their satellite suburbs, to become a characteristic of rural areas as well. With high land values and heavy investment in fixed installations dedicated to specialty enterprises, this rural sector of the community surrounds the urban-industrial-suburban sector as a shell which has lost the elasticity historically associated with country areas. Moreover, it exists in sufficient depth to have a profound effect on both its own and the city's problems of wastes management.

Cities have traditionally dealt with wastes by transporting them beyond their own immediate confines and discarding them in the least expensive way the public might tolerate, advancing from city dump to landfill or incinerator as necessity compels. Freedom to manage wastes in this manner is now vastly constrained. The once-rural shell is difficult to penetrate except at extremely long haul distances, currently judged to be prohibitively expensive. The alternative of retaining the wastes within the city is even more unsatisfactory in most cases. Land area is at a premium, and land use planning is generally not advanced enough to include refuse disposal objectives. Moreover, the constraint is often three-dimensional, for air pollution considerations limit the freedom to burn combustible wastes. In many communities the problem is compounded by the fact that the urban core itself consists of several incorporated cities, each confined by its own geographical and jurisdictional limits. For example, in the San Francisco Bay area some 83 separate but impinged jurisdictions and agencies seek to sequester solid wastes in each other's back yard at 77 locations under the watchful eye of a vigorous air-pollution control district.

Just as the city is confined by the surrounding rural sector, it, in turn, exerts pressure against the air-polluting, water-polluting, vector-producing, and other adverse environmental potential of that sector. Urban subdivisions press hard against dairies, egg and poultry establishments, and animal feeding enterprises. In California, for instance, single installations may fatten 3,000 to 6,000 steers annually; others maintain 10,000 to 100,000 hens. The fly-breeding potential of the 20 million cubic yards of animal manures produced each year at the zone of contact between urban and rural installations in California is little less than astronomical. Against such zones the city presses with enforcement of nuisance-abatement laws and extension of city limits which may overwhelm agricultural enterprise with ruinous taxes. Both fixed investment and the unavailability of land further away confront the agriculturist with the choice of going out of business, to the disadvantage of the entire community, or finding some way, himself, to resolve the environmental problems his activities generate. Collection of manures is expensive, and its disposal on land beyond the confines of the community is as difficult as is the disposal of urban solid wastes.

Other problems of solid-waste management in a modern community derive from agricultural pursuits in the high-density rural sector. For example, burning of tree trimmings and other plant residues accentuates the air pollution problem already begging solution in more than 10,000 U. S. communities.

Thus it must be concluded that, in a modern community consisting of impinged urban, industrial, suburban, and high-investment agricultural sectors, the problem of solid-wastes management calls for a community-wide approach for which existing fragmented jurisdictions are inadequate.

Public Attitudes

The attitude of individual citizens and public officials contributes in great measure to the problem of solid-wastes management. It might be said that any material becomes a "waste" when its owner or producer no longer considers it of sufficient value to retain. Any suggestion that he should thereafter invest more money in it, for the sake of disposal or any other financially unrewarding goal, is likely to be considered absurd, however inclined he may be to object to polluted water, smog, rodents, unsightly debris, and other conditions which result from his loss of interest in ownership. Ensnared in this public economic spirit, engineers and officials responsible for wastes management in the community have tended to apologize for the fact that their systems cost anything at all, often retreating from expedient to expedient on the basis of cost in dollars instead of helping the public understand that wastes management is worth whatever it costs within the framework of honest engineering and sound public health practice; and that the cost is the price man must pay for the benefits of a modern urban-industrial-agricultural society. Similarly, the administrative official of the city has often mistaken a policy of no-spending-at-all for the ideal goal of municipal government, or found it more politically and socially rewarding to confine tax spending to more popular public works, or to monumental developments having greater cultural appeal than wastes management.

The result has been a very low estimate of the cost the public can "afford" to pay for waste disposal, and a hesitancy to dedicate any resource values to such an end. This, in turn, has encouraged dump operators to function at the limit of public tolerance until, currently, in many localities a public reaction against the landfill or incinerator is occurring, thus producing a demand for better methods, which may involve unnecessarily high costs in the final resolution.

Clearly, the problem of solid-wastes management is in part the result of an uninformed public with a low degree of willingness to invest in wastes management and, at the same time, a high sensitivity to the esthetic values which poor management affronts.

Variety and Nature of Wastes

An increase in the variety and a change in the nature of solid wastes in recent years has done much to disrupt traditional concepts of disposal. Historically, refuse disposal by any but the most primitive methods of dumping on land or open burning has been concerned with refuse collected from individual households and commercial establishments within a city. But in the modern community, as previously noted, industrial and agricultural residues, cannery wastes, animal manures, demolition and construction debris, automobile bodies, and other junk also became a part of the residue to be managed in a manner suited to man's health and esthetic and social objectives. Thus, by extending the scope of the problem there has resulted a dislocation of technology as well as of the jurisdictional and physical systems of wastes management.

Dislocation of past inadequate systems of waste management is further rendered critical by the sheer magnitude of material to be handled. The traditional 2 pounds per capita per day has now reached an estimated 6-8 pounds in many localities. At such a rate the refuse from 130 million urban Americans is enough each year to cover 50 square miles with a compacted fill 10 feet deep.

Further dislocation of technology derives from the changing nature of municipal refuse itself. A historical spendthrift attitude toward resources is reflected both in an unconcern for wastes and a proliferation of such residues. So great were our national resources that we became an affluent society in spite of our wastage; and, once the natural harvest of the earth had been reaped by simple extractive enterprise, American energy and inventiveness were turned to a sophisticated industry capable of maintaining and extending that affluence. The by-product of this development has been the never-ending variety of new waste products from our industry. With opulence also grew the desire for greater convenience of living. The result is disposable containers, nonreturnable bottles, short-lived plastic objects, urban renewal, planned obsolescence, and all the other concepts and gadgetry which magnify the amount as well as the types of wastes that must be managed within a community. Garbage grinders now discharge to the sewer some 30 to 60 percent of organic matter once collected as solid wastes; plastics and nonreturnable containers have increased in volume, with profound effects on the combustibility and degradability of refuse; metal cans without a salvageable tin content are coming into use; and industry creates some 2,000 new products each year. Furthermore, the domestic economy has come to depend to a considerable degree upon the continued replacement of goods.

Thus, it may be said that a change in both the scale and variety of wastes characterizes the current problem of solid-wastes management; and that maintenance of the economy now demands that the volume of wastes be continually increased.

Educational Deficiencies

Closely related to public attitudes is a lack of education of personnel responsible for solid-wastes management in fundamental concepts and techniques. Public health officials are generally aware of the nuisance and vector problems associated with careless handling of refuse. Engineers may or may not have a smattering of formal training pertinent to wastes problems; and planners, public administrators, lawyers, and financiers who deal with urban problems get essentially no educational introduction to the matter of solid wastes. The result is that the problem of solid-wastes management, however vexatious, is often a secondary matter in the scale of important urban problems.

There is a particularly profound ignorance of the nature and potential of alternate methods of disposal and their effect upon land, water, and air resources. For example, a public official who opposes landfilling often cannot understand why incineration or composting is not adopted instead.

No one has explained to him that neither of these does more than reduce the amount and alter the nature of material which must be disposed of on land. Discussion of wastes problems then tends to develop around the matter of cost in dollars and to flounder in a well of ignorance.

Fundamentally, only the land and the ocean can be looked upon as ultimate sinks into which solid wastes can be discharged. There is no method of disposal, except dumping at sea, that does not return a large fraction of solid wastes to the land. Landfill, of course, has the potential to dispose of essentially all the solid wastes of a community by placing it on or under the land surface, but the degree of land disposal associated with other methods is often overlooked. To some extent this is the result of obsolete estimates of the amount of wastes to be managed, based on experience with municipal refuse alone. Although the organic content of the overall community-wide wastes has not been established, it is probable that one-half of the total amount will always have to be applied to the land even where incineration is practiced.

Clearly, there is a need for educating people concerned with urban affairs in the concept of solid wastes as residues of resources use which the land resource must accept either with or without appropriate land-use planning, as well as in the techniques of wastes management and their environmental and resource implications.

Limits of Technology

Technological considerations are involved in solid-wastes management in several ways. As noted in the preceding section, there is no single technique except landfill and dumping at sea that has the potential to accept all types of solid wastes. Incineration, composting, animal feeding, grinding to sewers, salvage, conversion, wet oxidation, digestion, spreading on soil, etc., are each applicable to only a selected fraction of solid wastes, and generally merely prepare that fraction for discharge to the land or sea in a more sanitary, convenient, or economical manner.

In no case, including land and ocean disposal, is the technology, however advanced, adequate to the needs. Deficiencies are of two types: those which require further research, and those which call for demonstration of known techniques. Since there are essentially no principles of stabilization or degradation of solid matter which are not presently known, research needs center on development of concepts, adaptation of process, and engineering of systems suited to solid-wastes management. For example, incineration, which has been widely adopted by major U. S. cities, is largely conceived as a device to reduce the refuse to a minimum volume. Re-examination of the method, both technically and economically, is now suggested by the fact that more than 10,000 U. S. communities recognize air pollution as a local environmental problem. Furthermore, as the percentage of plastics in refuse increases, so does the needed furnace temperature, with resultant shortening of the life of furnace liners.

Landfill techniques, although well established, are still but the crudest form of materials handling. Composting is stalled between the economics of production, the nature of an organization to manage the process, and agricultural uninterest in the product. Disposal at sea, disposal of organic fractions to the sewage treatment plant, disposal of sewage sludge, and long-distance transport are but a few of the inadequately explored problems, technically and economically.

Finally, no experience with the application of current techniques to the combined wastes of a total community is available.

The need for demonstration of known techniques arises from the fact that cities are notoriously and understandably incapable of raising risk capital for trying out new processes. Investment of public funds in an engineered process not already functioning in other cities in some tolerable fashion is too politically risky to undertake.

Thus the problem of solid-wastes management involves both imperfection of technology and a lack of demonstrations designed to identify and overcome technological difficulties and to establish the economics of improved systems.

Limits of Research

Failure of technology to develop from the results of research has had the effect of stalling solid-wastes research for more than a decade. Public attitudes of financial disinheritance of its rejected goods have been reflected in its support of research, with a further delaying effect on new discovery. This does not mean that researchers lost all interest in the problem or that support for good research could not be found. Rather it means that as long as jurisdictional and economic attitudes remained static there was very little that research could add to arrest the growth of the solid-wastes management problem. Fortunately, today, a change in public attitudes concerning resources management, the quality of the environment, and other social goals once again opens possibilities for research to contribute. Nevertheless, a backlog of unattempted research becomes one of the aspects of the problem of solid-wastes management.

Economic Considerations

Although the American tradition of wasteful use of resources leads to a reluctance to invest money in unwanted residues, the actual cost of municipal solid-wastes handling is an impressive sum, being estimated at some three billion dollars annually. Both of these economic factors work against the research, technological development, and demonstration needed to make possible the management of solid wastes in a satisfactory manner, as measured by the health, esthetic, and other standards and objectives of society. Thus, a serious aspect of the solid-wastes management problem is that, in spite of the expenditure of a large amount of public funds, the results are unsatisfactory; and the data to estimate the cost of satisfactory management in an individual situation are either unavailable or unevaluated.

Awareness of the Problem

It is virtually impossible to describe in a brief summary all that has transpired in the U. S. A. that bespeaks an awareness of the problem of solid-wastes management. However, there has been enough communication between men responsible for solid-wastes management throughout the country to make it possible to assess the nature of the problem and the progress being made toward its solution. In general, it might be said that each jurisdiction which has the responsibility for solid-wastes disposal has been increasingly beset by the growing wastes load and the social pressures against wastes management practices. Some have found unilateral expedients which are temporarily acceptable to their communities. Essentially all are looking for some better approach. Many are confronted with citizen demands for other uses of the land resource now dedicated to wastes disposal.

The American Public Works Association has held conferences and carried on committee work for several years to identify areas of needed research and encourage research groups to undertake the most urgent problems. The Public Health Service, in 1963, sponsored a National Conference on Solid Wastes Research, likewise to identify and publicize research needs. The American Society of Mechanical Engineers sponsored a Conference on Incineration in 1964. The American Society of Civil Engineers has a special committee on solid-wastes management which is very active in the field.

A rising public awareness of the problems confronting public agencies and jurisdictions at the technical and operational level of management was crystallized during 1965 by a number of developments at the federal level. Numerous reports on the solid-wastes problem were prepared for the President's Commission on Technology, Automation, and Economic Progress and the Federal Council on Science and Technology by the National Academy of Science and others. These helped to bring the attention of the national Congress to the nature and scope of the problem of solid-wastes management. Passage of bill S306 should now assure action programs which should prove more effective than the previous unilateral efforts of individual jurisdictions.

All of us here today have participated in efforts to stem the rising tide of solid-wastes problems. I shall not catalog in detail what we have accomplished, or evaluate our prospects for the future. That is the province of other speakers on the program. My point is that our efforts, however vigorous, have been too fragmented and piecemeal to do the job. As I view in perspective our efforts to contain the problem of solid wastes during the 15 years in which I have been active in the field, I am reminded of the story of the little Dutch boy who stuck his thumb in a leak in the dyke and so saved his community from disaster. In the story, this lad was properly hailed as a hero. But when one considers the hydraulics of his feat, it must be concluded that he was also a magician; for in the unrelenting "real" world, obstructing the discharge end of a hole in an earthen dyke could only aggravate the problem and lead to an accelerated failure. To a large degree our answer to the solid-wastes problem has been a "thumb-in-the-hole" approach; we have made heroic efforts, but only to see the velocity increase and the breach widen so vastly beyond the scale of our thumbs that we are on the verge of being overwhelmed. Perhaps, in the next two days we may visualize a more suitable approach to the problem of solid-wastes management.

DISCUSSION--THE PROBLEM IN PERSPECTIVE

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Professor P. H. McGauhey was scheduled to give the above-titled paper. Unfortunately, he had undergone surgery and was not sufficiently recovered to attend the conference. Mr. Frank Bowerman consented to paraphrase and interpret Professor McGauhey's paper. The originally prepared paper precedes Mr. Bowerman's presentation.

Before I move on to presenting and discussing Professor McGauhey's paper, I'm sure those of you who have known Mack for so may years will be pleased to know that he is doing well following surgery. I talked to him on the telephone last night, and he sends greetings. He certainly didn't wish to miss this meeting, particularly after the hard work and effort that went into its preparation by Dr. Hart and Dr. McGauhey, the co-chairmen.

Mack has permitted me, and I hope you will also permit me, to paraphrase what he has written; his very excellent paper will be presented to you, verbatim, in the Proceedings of this conference (see preceding paper). So with your permission, I'll talk about his paper and not attempt to present it to you in a word-for-word manner.

Along about 1950 the State Legislature of California became interested in the matter of solid waste. Now, that's quite a ways back as far as this thing goes; not as far back in history as many of you have been involved, but, as far as interest at the level of a State Legislature is concerned, that is pretty early in the game. The interest came to fruition in the form of a $50,000 grant to the University of California to form a Sanitary Research Center and to commence particular activities in the field of solid wastes. The money was spent largely to bring into being a facility at Richmond, near Berkeley. This field station very promptly took on itself the task of reporting the state of the art on composting, incineration, sanitary landfilling, and refuse collection practices as conducted in the Central Valley of California. The bulletins produced at that time were almost the sole source of reference for those interested in the academic features of those several solid-wastes activities. It was at that time that I first got to know Mack, when the University asked me to help in the preparation of their bulletin on municipal incineration. From that date to this, Mack and I have shared an interest in many of these activities, and that is why I count it a particular privilege to speak to you today about some of his thoughts.

From that day until this, the University of California at its many campuses--at Berkeley and Los Angeles and here at Davis--has interested itself in solid-wastes activities and has continued to do basic effort far beyond that initial $50,000 grant, which really just got things rolling. More recently they have moved into other areas of research involving air pollution, water pollution, and similar related activities.

Professor McGauhey has been much conerned about our national concept of waste. I think you'll agree with me that we are probably the one country in the world that can best afford to be wasteful, but I'm not too sure that I'm proud of that fact, because we may be squandering national values, natural resources, in a manner that may catch up with us at some time in the not-too-distant future. I was privileged in the last few weeks to tour France and parts of Spain. I was much impressed with the fact that the solid-waste problem is very much different in France and Spain from that in this country--because the people are not as wasteful as we are. They have problems, but many of our problems come about because we have been a nation with vast natural wealth: we have burned down the hardwood forests and coverted them into farms; we have mined the top soil and wasted it to the winds; and we have used our rivers as great sewers. Now we are finding that the day of reckoning has arrived. In the field of solid wastes we will perhaps find that much of our problems will be minimized if we can change our national concept of waste, if we can develop a national conscience regarding the manner in which we create and destroy things without making greater use of them.

Professor McGauhey is quite concerned about the effect of the growth pattern of our cities, which can be seen in clear evidence here, where the city--the core of the city, the urban area--is hard to separate or to distinguish from the industrial and agricultural areas which surround it. The old concept of getting out of the city into the country doesn't hold much any more, because, even after you leave the city limits, you are still within a highly-developed and a highly-integrated part of the city's activities. Yes, it may be a farm, but the farm is valued at such a price and the fixed facilities are so high in value that it is not a flexible thing any more, and the farmer, if he finds he is close to highly-valued lands suitable for subdivision, can't simply abandon his facilities and move to cheaper ground, because he has no cheaper ground to move to. And so our old concepts of being able to haul things out of the city into the country--out into the area of less value and just leaving them--no longer hold. We are bound in, we are ever-more-tightly bound in, by the fact that the industrial and agricultural areas which surround our cities are a part of the city structure; they're no longer separate, they are no longer just countryside; and they are an invaluable and a necessary part of our total community. And, how these things interrelate is pretty interesting.

In Los Angeles County, for instance, we found that truck gardening in the middle of this highly-urbanized community suffered very badly from air pollution, so much so that spinach growing, for example, had to move out of the Los Angeles basin entirely. The smog would ruin the spinach crops through a form of blight; the same thing is now happening to the truck gardening of flowers. Smog intensities in Los Angeles County have become serious enough to have moved entire agricultural areas out of the urban center into the valleys, the desert, and the Central Valley near Bakersfield, where it is out of immediate contact with severe air pollution. Then, of course, there is the other relationship. The farm, by its very nature, can create nuisance situations involving flies and odors, so that you not only have the urban dweller causing air pollution and other nuisance affecting farm activity, but the farming activity affecting the health, welfare, and the esthetic satisfactions of the urban dweller. What generally happens is that there are more people in the urban community--it's a more concentrated population--and so, as they enfold or engulf the farm community, they pass laws to limit farmers' activities, they make their activities more expensive, they may incorporate them and cause them to become part of the city complex and include them under city taxation. These are very difficult interrelationships, and, so far, I don't think we've been handling them on a management basis. We've been handling them piecemeal. As it happens, it happens, and it's just sort of "tough". But I don't think we can afford this type of interplay much longer. We are going to have to learn that our urban, industrial, and agricultural communities can grow and thrive only in an interrelationship which allows all areas to share in use of the environment.

The freedom that the cities have enjoyed by simply hauling things outside the city has been of long standing, and, as the Chancellor told you earlier, such practices as open burning, even on a campus such as this, appear to be still in the picture even at this late date. But, because of the ever-increasing need to provide adequate answers for all of these several problems, it appears that there will have to be common solutions brought into being which may well eliminate some of these freedoms of choice. It is quite possible that the limitations that have been placed in Los Angeles County upon open burning will be placed elsewhere. In 1947 a ban on burning at open dumps was enforced in Los Angeles County. Ten years later, in 1957, a ban on the backyard incinerator was passed, so that the commonplace practice of carrying combustible refuse to the backyard and burning it in a small, inefficient incinerator became prohibited. These things, then, are matters of change which are inevitable as we develop a higher sense of responsibility toward pollution. As we feel a more urgent need for getting together as an integrated community, we are going to have to abandon some of the practices that have been time-honored but simply cannot survive in our present social and economic system.

In some agricultural communities the intensity of land use is really quite phenomenal. Professor McGauhey points out that in some cattle

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feeding pens, as many as 3000 to 6000 steers will be marketed annually in each individual enterprise. In another, a single owner will maintain tens of thousands of hens on an egg farm in a limited area.

Professor McGauhey goes on to point out, however, that it's not just the presence of the pens or poultry farms but the fly-breeding potential, the odors, the other nuisances that go along with these activities, that urban communities cannot cope with.

Dairy manures sometimes have value as fertilizer, and we talk about compost and the creation of humus for agricultural use, but the present value of dairy manure in Los Angeles County is minus $2 a ton. That is, they will pay you $2 a ton to come and get it and haul it away. This is an example of some of the difficulties one runs into in getting rid of materials which may seem to have some apparent value, but which, on investigation, prove to have negative value on the current market.

One thing that impressed me in France was the vast number of small rural fires; I found that the fires all related to agricultural activities in getting rid of debris left over from the trimming of grapevines, trees, and other farming activities. And I found that open burning was prevalent because the burying of agricultural by-products isn't really entirely satisfactory if disease propagation from plants to the ground is still possible. To be sure that certain diseased plants do not transmit to other plants, one of the best things to do is to burn them. Here we have one aspect of the solid-waste program as it applies to agriculture that may be easily compensated for in most farm areas where each small farm burns its own small pile, but which may be very difficult to accomplish in some of our urban-industrial-agricultural complexes.

Professor McGauhey goes on to point out that the problem is difficult not only because of the manner in which our communities have grown together, but in the fact that there has not been any unified organization of an attempt to solve the problem. There has been a fragmented jurisdiction. It has not been one group's job. It has been the job of all, and I think you know only too well what kind of a job is usually done when it's everybody's job. And so it seems that one of the big problems in the solid-waste field has been the fact that everybody can do the job or thinks that he can.

In Los Angeles County, a study we made in 1949 on refuse collection and disposal showed that every city wanted to do its own refuse collection because every city could buy trucks and hire drivers and put them on the streets and pick up the refuse; however, the one thing that every city couldn't do was to dispose of the refuse which was picked up, and so the Sanitation Districts' system finally evolved into strictly a disposal system. The need was for a concerted effort to find solutions to the disposal problem. But the seeming simplicity of the solution, where each city has its own ability to pick up refuse, is often the reason why the collection of refuse is being handled so poorly. In Los Angeles County, which I know better than other areas, there are 77 cities and many county and district activities, and the nature of the collection service varies widely. Some cities have excellent collection practices, while others have collection practices which leave something to be desired. Fragmentation is one of the problems that is most difficult to solve because many people feel that local autonomy is threatened, and until the need becomes so pressing as to cause a concerted effort by these fragmented jurisdictions to get together, they keep on doing the job separately.

The public has not been very interested in waste products, because it is hard for some people to understand why they should spend more money on something that has no value. In New York City a Sunday edition of the Times costs 25¢. From the cost of disposal in New York City it can be shown that it costs about 7¢ to get rid of a copy of the New York Times. Who pays the 7¢? Through taxation, everybody pays the 7¢ per newspaper to get rid of it, but the person who pays 25¢ for the copy doesn't identify with that 7¢ cost of disposal. The public has taken an attitude of uninterest in waste products and will probably continue to do so in spite of what we say or do. It may prove necessary for us to try and figure out some rather clever ways of educating the general public to realize that the things that they no longer want still represent a significant negative value.

Most of us assume that automobile bodies represent value inasmuch as they weigh quite a bit and most of the material is metal. Why not let people go out and salvage them? Well, the cold, hard facts are that in most parts of the United States today a car which has been abandoned and must be picked up and hauled to a point of disposal represents negative value. It costs more money to pick it up, haul it, process, and salvage it than it does to let it rust where it was abandoned. Various novel suggestions have been made to alter this. Perhpas one could, at the time of purchase of the automobile, pay an additional $15 to $25 which ensures that at the time that the automobile is abandoned somebody will be willing to go out and pick it up because there will be a bonus of $15 to $25 for getting rid of that particular auto. At least this would help the general public identify with waste products so that it realizes the things that you and I are here concerned with are the things that they use and abandon; we're doing the job that they can't do, because each person doesn't have the facilities for disposing of the things that they themselves have used and discarded. Try to figure out how you're going to get rid of an automobile if you don't have some place to take it to!

Another thing that has confused the picture has been the lack of understanding of the amounts of material created by the various "wasting" activities of the country. It has been only within the last five years that there has been a general awakening to the fact that there are many more wastes to be gotten rid of than those that come from homes and apartments. For years we went along talking about residential refuse collection and disposal as if it were the major solid-waste problem in the United States; most of our text books and reports indicated that this amounted to somewhere around 2 or 2½ pounds each day for each one of us. That figure isn't far off from what you and I dispose of through our normal daily living activities, but it doesn't include large tonnages of material that originate from industries, from commercial activities, and from the farm. When we add all these figures together, they become rather surprisingly larger than the 2-pound-per-person-per-day figure that we've been kicking around for many years.

In Los Angeles County, recent studies indicate that an aggregate for the total community is closer to 7 to 8 pounds per capita per day. Also, we have been rather surprised to find out that at our major landfills, where we weigh things quite accurately and keep track of the origin of materials, only about a third of the material comes from homes and apartment houses; about another third comes from industrial and commercial activities; and, this may be surprising, the final third from demolition sources. And Los Angeles is not the only place that's being rebuilt in the United States today, because, everywhere one goes, there are signs of renewal, signs of urban development and redevelopment. So this is probably a figure that will become accepted in our current technology. We cannot any longer consider the primary problem to be solid wastes from homes. We have to consider industry, commerce, and agriculture in the total picture, because these are the things in the aggregate that are going to use up our waste disposal facilities.

Professor McGauhey, in speaking about the present status of technology, feels that the availability of technical understanding far outreaches our state of development. To phrase this a little bit differently, the research in many areas has already been done, but this research has not been applied to "doing things." Reports on many research activities lie on the shelves of various universities, various technical institutes, without application, and this has been in part because there has been no mechanism for translating the technical findings into a "system" for operation. One of the things that seems quite apparent is that we really have no way of putting to work on a substantial scale some of the ideas that sound so good that we wonder why they haven't already been done. In building automobiles, or in the field of marketing and sales, this is quite different. If an idea has merit and the industry can use that idea to benefit sales, it will be developed. But how are you going to interest, say, the plumbing industry in giving up present methods of constructing plumbing facilities and starting all over again? Obviously you can't, and so, if a completely new system is to be designed, something which may produce better end results, but results which may be 10 to 20 years off in the future, there's going to have to be devised some clever method for trying out some of these things. Professor McGauhey points out that the technology of composting was pretty well described in University of California reports back in the early 1950's, and yet the translation of that into a workable system for composting has failed. Composting seems to lack, first of all, a market for the end result, and secondly, an organizational scheme or set-up which will allow development of the product, its sale, and the integrating of composting into the over-all disposal system. Most composting schemes have failed because they have been "entrepreneur-oriented." Someone decides that he is going to make money by composting, so he builds a composting plant and works out some sort of arrangement with a city or community to take its wastes and convert them into something which has value. Well and good, but if the value isn't high enough to pay the costs, then the private company either finances the operation through subsidy or the whole project fails because the income doesn't match the amount of money it costs. Of the successful composting ventures that have existed for long periods in European practice and the few in this country, all have been oriented toward a waste disposal concept where the community itself has paid a substantial part of the cost of operation. Witness the VAM operation in Holland. Through a governmental enterprise, the communities which dispose of their waste to VAM for composting pay essentially the costs of incineration into the project. The waste is transported to an area where it is composted and converted into a product that the farmer can use. However, the farmer can't afford to pay the total cost of the composting venture, so he pays about an equivalent to what the community paid to get rid of the waste in the first place, and, together, the sum total of the moneys paid is sufficient to balance the costs of the composting operation. Perhaps we need some schemes in this country which, call it what you will, may involve some sort of governmental support or subsidy. I look forward with interest to hearing later in the program from those in the Public Health Service who will tell us the means whereby the federal government may be able to support programs to develop techniques, processes, and systems from the technology that already exists in the many technical institutes and universities across the face of the land.

The researcher hasn't always had the support of the public; many studies have had to be supported at the university level more or less as part of the university program. California has taken a giant step forward in supporting these types of studies over the last fifteen years. Some interest has been shown in other states along this line at state-supported universities, but most of the research conducted to date in this country has not received strong public support.

Professor McGauhey feels that most of the research has been directed along three lines and that these are the most likely ones to which further research should be directed. First of all, and it's notable that he would put this number one--reduction of the quantity of waste at the source. This gets right back to what we said earlier about our profligate nature, our willingness to just throw things away without making much use of them. The second is recycling and reclaiming waste materials. This is reuse within an industry as well as reuse within the community; the taking of a product from one area of use and putting it to work in another area of use. And third (the one we tend to think about the most), improved methods of disposal.

Professor McGauhey, being in the field of education, has been much interested in the training of personnel, and it is his observation that it is exceedingly difficult to get college students oriented toward solid-waste training. I was involved in this problem when I was taught waste disposal in evening sessions for several years at the University of Southern California. However, I found a very strong interest on the part of the night students, because these were men who were involved in full daytime work and several of them were already working in the field of solid wastes. But the situation is different with daytime students, young men, not currently employed, who are looking toward the future, when they're going to be doing something dramatic and glamorous, certainly not something involving refuse and garbage and such mundane things of daily living. The principal success achieved so far in interesting young people in moving into solid wastes has been after graduation. Very little has been accomplished by way of recruiting young engineers at the university level to enter advanced training in solid-waste work, leading to advanced degrees. As a matter of fact, there are only about three universities in the United States today that are doing work at the graduate level in the field of solid wastes. However, this is not the fault of the universities, because if they had such programs, they wouldn't have anybody taking them. But there should be, at some point, an awakening of young people going into engineering training to the fact that engineering in environmental health does not necessarily mean water and sewage, but involves many other forms of wastes. The training program should be broadened greatly so that these young people come out with a knowledge which is much broader and more comprehensive than what they have now.

Finally, Professor McGauhey speaks of what is being done and states that it is virtually impossible to try to summarize what's being done in solid wastes in the United States today, because nobody knows. Research and development are being done on such a diversified but limited scale that, in order to find out what is being done in the United States today, you'd have to visit almost every campus and almost every city hall and public works department and talk to the people involved and find out what they're doing. You would be surprised, as I have been, at the high degree of interest of the people who are doing the job. The engineers, the technicians who are working with the solid-wastes activity, are very much interested in what they need to do, because they're going to be the ones who are going to have to come up with the answers if somebody else doesn't help them out. And if some university doesn't come along with a nice solution, they will still have to solve their problem. They're still going to have to work out some sort of an expedient and figure out what to do tomorrow and the next week and the week after and next year. There is no lack of enthusiasm and interest on the part of operating personnel, and I find that many studies are being undertaken at the local level. But it is somewhat like a centipede--it's got so many legs that you can't keep track of all of them. So to try to summarize everything that's being done, all that can be said is this: There's a lot more that needs to be done than is being done, and it needs to be done on a scale that would multiply things by 10 or 100 or perhaps 1,000, because what is being done right now is only "nibbling" at the solution. Most "solutions" today are only a series of short-term expedients that get us on to the next problem. One has to take one's hat off to those who have been working in this field, because they have been pretty much on their own. There has been no coordinated nationwide effort to support a program of study until this past year. Certain organizations have done much. The American Public Works Association has been vitally interested because it consists of people who have to do the job, so their interest is personal. The American Public Works Association has held many solid-wastes conferences and has had very active committees to study the problems relating to solid wastes and their collection and disposal; the APWA has cooperated with the U. S. Public Health Service in planning several conferences. The American Society of Mechanical Engineers sponsored a national conference on incineration in 1964, and will again this year. The American Society of Civil Engineers has special committees on solid wastes. These committees, these associations, have been like "voices in the wilderness." They have not really been able to work together on a coordinated effort, because individual efforts were too small. And so, most of the emphasis has been on short-term expedients. Many of the studies, many of the efforts have been merely to try to state the problem. And, of course, you've got to start there; you can't try solving a problem until you find out what it is. But isn't it embarrassing, after all these many years, to find out that we're still trying to identify the problem of solid wastes in the United States?

The federal government, through the President's Science Advisory Committee, in a report titled "Restoring the Quality of Our Environment," and a more recent document, "Waste Management and Control," by the Committee on Pollution, National Academy of Sciences, have attempted to state the problem. These reports, if you will take the time to read them, will probably frighten you; they are not intended to. They are written by people who didn't come up with things which were fanciful, things designed to excite you and interest you. The reports are simply based on facts, brought together in single reports for the first time, to present some sort of a unified picture of what is happening to the United States today in terms of its environment. In each report you will find that solid wastes play a material role and have been given significant emphasis.

If I've said anything at all this morning, I've tried to give you a little bit of a keyhole peek into some of the problems and, hopefully, some of the solutions that might be coming up. This great new world of tomorrow can scare you, but, at the same time, I think it can be pretty exciting. Hopefully, if we reach far enough and look well and long into the future and do good enough jobs now to preserve some of the beauty of that brave new world of tomorrow for our youngsters and their youngsters and the generations to come, a grateful public will someday recognize the service we have provided them.

THE PROBLEM IN DETAIL

J. H. Hickey

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Mr. Hickey is a professional planner. He is an active member of the American Institute of Planners, and is presently serving on the National Policy Committee on Metropolitan Planning of that society. He has been a planner for the Detroit metropolitan area, and for the State of Ohio, and is now working in the San Francisco area with the Association of Bay Area Governments, headquartered in Oakland, California.

The collection and disposal of solid wastes is rapidly becoming one of the major unsolved problems of urban areas. To protect public health, every community must provide a regular and sanitary system of refuse collection and disposal. For the small community located well outside of the large metropolitan area, disposal of an average of four pounds of refuse per person per day presents less of a problem than its collection. For the large metropolitan center, however, the problem of disposal as well as collection is subject to a multiplier that in some cases is in the millions. For the nine-county San Francisco Bay Area today, the problem of collecting and disposing of an average of four pounds of refuse per person per day must be multiplied by a population of 4,000,000 people. Within twenty years, this multiplier could easily be 8,000,000 or more.

How is the problem of disposing of some sixteen million or more pounds of refuse per day in the Bay Area being handled today? Are present methods of disposal and existing facilities adequate to meet future needs? These are some of the questions raised by individual cities and counties in the Bay Area. Working through the Association of Bay Area Governments, in 1962, the cities and counties took steps to obtain the answers.

Before describing the waste disposal problems we are facing in the Bay Area, I would like to take a minute or two to describe the who, what, and when as related to the Association of Bay Area Governments. I think it is important to do so for two reasons: first, so that you will have some idea of who is talking to you; and secondly, this information is important in regard to the subject of this conference.

The Association of Bay Area Governments was created in January 1961. It was founded in recognition of the fact that the physical, economic, and social well-being of the entire region and of its individual communities requires continuing areawide cooperation and coordination of policies, plans, and services.

The primary function of the Association is to provide a framework for dealing with regional problems on a cooperative, coordinated basis. Although the Association is not itself a government agency, it provides the means by which strong, vital units of city and county government work together in solving regional problems and in formulating and implementing regional development policies.

Formal organization for the Association is provided by contractual agreement between the member cities and counties, acting under the authority of the Joint Exercise of Powers Act of the State of California. Present membership includes eight counties and 83 cities, representing collectively more than 99 percent of the total Bay Area population.

The primary objectives of the Association are:

1. The identification and study of problems, functions, and services in the San Francisco Bay Metropolitan Area and the making of appropriate policy or action recommendations.
2. The review of proposals for metropolitan or regional governmental agencies and the making of appropriate policy or action recommendations.

3. The review of such other metropolitan or regional functions as are determined by the Association to be appropriate for consideration.

The Association is currently active in the following fields: regional planning, water pollution control and waste drainage planning, open space and recreation facilities, uniformity of building regulations, law enforcement communications systems, and regional information systems.

The Regional Planning Program, financed in part by a Federal Urban Planning Assistance Grant, is designed to produce a comprehensive regional plan and continuing planning to assist in the growth and development of the region. A full-time planning staff, working in close cooperation with local agencies and other regional units, is now completing a first-stage preliminary regional plan, with special emphasis on Bay shoreline development, refuse disposal, parks and open space, and transportation.

The Association's programs are financed by membership dues and special assessments and by grants in funds and services from other regional agencies and state and federal governments.

One of the four areas of special study included as part of the regional planning program is the problem of solid-waste disposal. To assist the Association in the early stages of its planning work in dealing with refuse disposal, the California State Department of Health assigned two of its top people to work full-time with the Association's staff on a study of refuse inventory needs. My description of the Bay Area's refuse disposal problem here today is based on the results of that study, published in August 1965.

An inventory was made of existing disposal facilities to determine the adequacy of refuse disposal sites in the Bay Area, to evaluate future disposal needs, and to consider current methods of operation.

In order to estimate the amount of material handled at each disposal site, it was necessary to evaluate estimates of quantities obtained from disposal-site operators; truckloads, quantities, and customers as estimated by refuse collectors; actual field measurements of quantities; and estimates of amounts of land volume used. In many cases, there was a complete lack of accurate information relating to quantities of material disposed of at various sites.

Only one site out of the seventy-seven sites in the Bay Area routinely weighs incoming refuse. A few sites periodically weigh incoming refuse for a limited period in order to establish basic figures for quantity estimates. After careful evaluation of all of the sources of information, it is felt that the estimates for the individual sites during 1963 are as complete as it is possible to provide under present conditions.

The results of the survey indicate that approximately 2,866,000 tons of refuse were disposed of in the seventy-seven disposal sites in the Bay Area. This tonnage of material, under average compaction, represents a volume of slightly over 4,300 acre-feet. When cover material is added, this volume represents 525 acres of land filled to a depth of ten feet.

According to the California Department of Finance, the estimated population of the nine-county Bay Area in 1963 was 4,076,000 persons. Based on this population and the above tonnage, the per capita production of refuse during 1963 in the Bay Area was 3.8 pounds per day. The per capita production for the various counties ranged from a low of 1.8 pounds per day, in Napa and Solano Counties, to a high of 5.5 pounds per day, in San Francisco. The difference in the range between these two figures is due in part to the large volume of unrecorded disposal of refuse by individuals in the more rural areas, including considerable burning; lack of complete information on quantities disposed of at landfills; and the greater volume of demolition and construction waste generated in the larger urban areas.

Insofar as possible, an attempt was made to evaluate the extent of the "special-wastes" problems in the Bay Area. This category includes the various wastes produced from industrial, agricultural, and urban activities which are not normally considered a part of the community refuse problem. The various wastes investigated, for which quantities were obtained, include greenhouse wastes, street and highway sweepings, cannery wastes, demolition wastes, agricultural manure, orchard prunings, dried sewage sludge, garbage used for hog feed, and junked automobile bodies. Approximately two million tons of this special waste were produced in the Bay Area in 1963. Descriptions, tonnages, and methods of disposal of these wastes are given in Table 1.

Table 1. Special waste production, San Francisco Bay Area, 1963

Description of waste	Annual tonnage	Primary method of disposal
Greenhouse wastes	12,600	Burning
Street & highway sweepings	11,700	Landfill sites
Cannery wastes	200,000	Landfill sites & ocean disposal
Demolition & construction	440,000	Landfill sites
Miscellaneous industrial	65,400	
Agriculture manure	1,026,000	Spread on fields
Orchard prunings	169,000	Burning
Dried sewage sludge	33,300	Agriculture use
Hog feed (garbage & swill)	47,000	Fed to hogs
Junked automobile bodies	56,000	Scrap & salvage

How much of this waste will eventually find its way into sanitary landfills or other future disposal plans is difficult to determine. If, however, this material which is burned, spread on fields, or otherwise disposed of were added to the material presently going into sanitary landfills in the Bay Area, it would present a yearly total of 4,300,000 tons of waste material, or a theoretical per capita production of 5.7 pounds per day. This figure, 5.7 pounds per capita, would represent the maximum amount to be considered in planning for future landfill facilities.

Refuse disposal in the San Francisco Bay Area is almost exclusively by means of sanitary landfill.

In addition to landfill operations are a few small incinerators serving individual institutions or schools. During 1963, there were seventy-seven established refuse disposal sites in operation in the Bay Area. The sizes of the individual sites range from one or two acres to over 500 acres. Fifty-five of the seventy-seven sites accept garbage in addition to other materials, whereas twenty-two sites are classified strictly as rubbish disposal areas.

Private interests control a great majority of the currently available disposal capacity in the Bay Area. Although public agencies own 36, or almost half, of the seventy-seven disposal sites, they own only twenty percent of the total available disposal volume. Many of the publicly owned sites are maintained and operated by private contractors. It is interesting that in the San Francisco Bay Area, with a population of four million people, a service as vital to the public health and welfare as refuse disposal is left almost entirely in the hands of private operators.

There is a trend toward more public ownership of disposal sites. This is due primarily to the increasing shortage of available land and the difficulty of purchasing such land for refuse disposal without condemnation. Some counties, including Napa, Sonoma, and San Mateo, have recently acquired land for refuse disposal for use by the various collection agencies. In Sonoma County, all disposal sites except one city-owned site are owned and operated by the county.

Currently, sixty-four percent of the available land being used for refuse disposal is found adjacent to San Francisco Bay--36 percent is in the form of tidelands and 28 percent is classified as marshlands. The reason for the location of these sites in relation to the Bay is the ready availability of this land for fill purposes, their relatively isolated locations, close proximity to urban areas, public and private interest in reclaiming marshlands for more intensive use, and ready access to major highway routes. Almost all of these sites utilize the "area fill" method of refuse disposal. Since cover material is generally scarce, it is usually imported, or excavation and demolition material is utilized. In the case of tidelands, the general practice is to construct an impervious dike around the periphery of the disposal area to prevent material from seeping or floating into the Bay, creating pollution or nuisance problems. Following construction of the dike, the area is dewatered, and filling is begun. Many of the inland sites use the cut-and-cover method where the land is relatively flat, or the area-fill method where a canyon or depression is being filled. Cover material in these sites is generally excavated from the disposal area. Although most all of the disposal sites in the Bay Area may be generally classified as landfills, only a few may be classified as "sanitary" landfills. The purpose of the survey was not to evaluate the operational practices in regard to sanitation, engineering, and nuisance prevention; however, throughout the survey it was apparent that in some of the disposal sites the practices and techniques could be improved considerably. Field survey results showed, for example, that only about ten percent of the landfill disposal sites apply cover material on a daily basis.

Since the San Francisco Bay Area Air Pollution Control District placed a ban on open burning on refuse dumps, in 1957, there has been no burning at disposal sites in the six counties that lie within the District. The three counties of Napa, Solano, and Sonoma, however, did at the time of the survey allow burning of combustible material at the disposal sites provided local fire regulations were followed. At present, there are some seventeen sites in these three counties where some burning of combustible material is being done.

As of 1963, there were 5,006 acres of remaining available land in the seventy-seven existing disposal sites in the Bay Area. At contemplated fill depths, this acreage represents a total available disposal volume of 90,645 acre-feet. As pointed out in a previous section, 4,300 acre-feet of refuse were produced in the Bay Area in 1963. The life expectancies of the various individual disposal sites vary from one to fifty years. Based on projected population figures for the Bay Area, with resultant increases in refuse production, this total existing disposal volume would be sufficient to 1977 if used in an effective and efficient manner. Many areas, however, will reach a critical shortage of disposal space before that time.

Future refuse production figures for the San Francisco Bay Area, even when using the conservative value of 4.0 pounds per capita per day, indicate some staggering quantities of waste material. In 1963, the survey results showed a refuse production of almost three million tons, not including any of the special or agricultural wastes, in the Bay Area. In terms of disposal volume, a total of 4,300 acre-feet were required. By 1985, the Bay Area will be producing 5,325,000 tons of refuse per year, requiring 7,800 acre-feet of disposal volume. Between the years 1963 and 1985, a total of approximately 90,900,000 tons of solid waste material will require disposal. This quantity of waste material will require an estimated 132,500 acre-feet of disposal volume. Added to this figure is an additional 26,500 acre-feet of volume required to allow for cover material and waste, or a total need of 159,000 acre-feet of refuse disposal volume.

Projecting further to the year 2000, the Bay Area, it is estimated, will be producing 6,900,000 tons, or slightly over 10,000 acre-feet, of refuse per year. Between the years 1963 and 2000, a total of 182 million tons of refuse will be produced. In terms of disposal volume, this will require over 265,000 acre-feet of volume. With cover material, a total of 318,000 acre-feet will have to be provided. The actual land area required is dependent upon the depth of fill. If, for illustrative purposes, we assume that two ten-foot lifts are used, then a total of 16,600 acres of land would be required.

During 1963, there were approximately 5,006 acres available for refuse disposal in the seventy-seven existing refuse disposal sites located within the nine-county San Francisco Bay Area. At contemplated fill depths, this acreage represented a usable disposal volume of 90,845 acre-feet. If all of this volume could be utilized by the Bay Area as a whole, it would be sufficient to last only to 1977. By the year 1985, there will be an estimated disposal volume deficiency of about 41,985 acre-feet, and by the year 2000 an estimated deficiency of 175,345 acre-feet.

I would like to go back now to a subject mentioned earlier--the Association of Bay Area Governments. One of the more frequently quoted reasons why solid-waste disposal needs are not resolved at the metropolitan level is the inability of local city and county governments to even agree that there is in fact such a problem. If this statement is valid, then, through the Association, we have made a start toward solving solid waste disposal problems in the Bay Area. The facts and figures just presented were assembled as one part of the Association's Regional Planning Program. As such, it was not required that this information be published in a separate detailed report form, and yet it was--for the following reasons:

1. To present for the first time an objective report dealing with the refuse disposal problem on a regional level as the basis for:
    a. An awakening of the general public and public officials to the seriousness of the refuse disposal problem and the need for immediate consideration of both long-term solutions and short-range improvement programs. Any solution to a problem, no matter how good it may be, can be evaluated only in terms of the problem it is intended to solve. If a person is not aware that there is in fact a problem, then any proposed solution is meaningless.
    b. The development of more detailed studies and plans for refuse disposal programs on the local level.
2. To point out a need for the initiation of local demonstration projects to investigate the development of new disposal methods.

As a next step toward a solution, the following study recommendations are currently being pursued in varying degrees by the Association:

1. Steps are being taken to investigate alternative methods of solid disposal. Sanitary landfill, as currently conducted in the Bay Area, cannot, because of the potential size of the land areas involved, be considered as the exclusive long-range solution to the regional refuse disposal problem. More information is needed regarding alternatives, including:
    a. Establishment of demonstration programs to investigate alternative methods of disposal such as: composting, incineration.
    b. Selection of locations in the Bay Area with critical disposal problems as the sites for demonstration projects, since those areas would benefit from such a program.
    c. Investigation of programs and projects related to alternative methods of solid-waste disposal and demonstration plants that would qualify for state or federal assistance in the planning, construction, or operation of such projects.
2. Until such time as alternative methods can be made operational on a large scale, planning for continued solid waste disposal by the landfill method for the Bay Region should include:

a. Identification of additional landfill sites in accordance with a general plan for the region to meet anticipated needs in critical areas. If the disposal sites acquired were large enough to accommodate sanitary landfill, they would more than accommodate other disposal methods.

b. Development of programs to improve operational practices at existing disposal sites to minimize nuisance factors and provide for more efficient use of existing and future disposal sites.

   The general picture the public has of a refuse disposal operation is of an "odorous, unattractive, nuisance-generating garbage dump." Improved operational practices could soften this image and establish landfill operations when and where necessary as an acceptable land use.

   Present landfill practices establish built-in limitations on future uses of disposal sites. Improvements in the degree of compaction--by pretreatment of bulky wastes, for example--or segregation of materials would make possible a wider range of future land-use developments.

c. Programs to ensure better measurements of the quantities of solid waste being produced in the Bay Area. One of the potential obstacles to planning for future refuse disposal programs in the Bay Area is a lack of reliable data on the quantities of refuse being produced. In the absence of this information, future planning must be based on estimated figures. Possible programs to provide the information needed include the weighing of material at disposal sites, maintenance of complete records by collectors and disposal-site operators, periodic field measurements of the capacity of disposal land utilized, and detailed reporting of waste production by industries and other special-purpose agencies. This information would also help inform the private citizen as well as the public official of the extent of the problem as it exists today and is likely to in the future.

3. Further consideration on the regional level of every potential solution to the problems of solid-waste disposal in the Bay Area. While the collection of refuse can be adequately handled by individual cities or counties themselves, disposal of the refuse collected is of such magnitude that it is clearly a regional problem in the Bay Area.

4. Further research and study of a broad variety of administrative and operational alternatives leading toward an areawide approach is recommended, including:
    a. The prospect for voluntary consolidation of the planning and operation of facilities between neighboring communities or counties as an expansion of current disposal programs being conducted by individual political subdivisions.
    b. The prospect of creating an agency whose jurisdictional boundaries would be dictated by economic and/or engineering principles rather than political or other considerations.

Every journey from where you are to where you want to go begins with a first step. In the Bay Area, through the Association of Bay Area Governments, we have made a beginning, a first step, toward the solution of one of the difficult areawide problems of urban living.

SYSTEMS ANALYSIS--A GENERALIZED APPROACH TO TECHNOLOGY

John A. Logan

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Dr. Logan was not always president of a college. He has been a sanitary engineer with the Rockefeller Foundation in the International Health Division. He has taught engineering at Iowa State, the University of Missouri, and at Northwestern University. It was at Northwestern that he teamed up with mathematician colleagues and pioneered the application of management science to sanitary-engineering problems.

I was pleased to hear the remarks expressed by Governor Brown's representative this morning; if there was a theme for our meeting over this two-day period it might very well be the statement that we in California, as in the rest of the nation, are on a collision course with disaster. This applies not only to the problem of solid wastes, but also to air pollution, urban sprawl, water pollution, and all of these related problems in which we have a direct or an indirect interest.

It will become obvious that I am speaking primarily from the point of view of an educator, although I hope that what I have to say has some relevance to everyone here.

As you know, there has been a great deal of discussion during the past year about engineering education, sparked primarily by a new report published by the American Society for Engineering Education. The report recommends the extension of the normal period of engineering education from 4 years to 5 years, and indicates that large numbers of men should go on to 7 or 8 years for the PhD.

It is obvious to all of us that there are now more engineering tools available; there is more to know about engineering. It is increasingly difficult to include all of this material in a 4-year program, but it may be that the ASEE and educators are missing the point. The problem is not how much formal education it takes to acquire all of these tools but, rather, what kind of engineers we are trying to educate, what kind of engineers we are trying to train. I think that my remarks will have some bearing on this point.

Quite often when we consider problems of this kind, it is useful to go outside of the engineering profession to see what others think about what engineers are doing. There are two references which I consider particularly relevant.

The first is an article entitled "The Anti-Leadership Vaccine," by John Gardner, formerly President of the Carnegie Foundation and now Secretary of the Department of Health, Education, and Welfare. Mr. Gardner decries the increasing specialization which is part and parcel of our educational pattern today, turning out increasingly greater numbers of experts able to deal only with minutiae; able to deal only with the small problems that are posed them. At the same time we are neglecting the education of leaders; men able to see problems in their broad spectra and willing and able to make decisions in a leadership role. This, I contend, is a direct challenge to engineers. Because of the nature of engineering education, engineers are by nature "generalists," educated and able to make leadership decisions.

The second publication I recommend is a book from a rather unexpected source--England, which has been neglecting its engineering education for many years. Oxford and Cambridge and other great universities have considered engineering to be somewhat beneath their dignity, and it is surprising that Sir Eric Ashby, who is Master of a Cambridge College and an eminent British scholar, has pointed out something about engineering which I think is of importance to all of us. His book, "Technology and the

Academics," outlines the growth of technology throughout the world and the effective way in which it has been used in the United States to develop the kind of country, the kind of economy, which we have at present.

Sir Eric reviews the issue raised by C. P. Snow regarding the Two Cultures, Humanities, on one hand, and Science, on the other. Snow's thesis is that these cultures do not seem to have any common meeting ground and are moving further and further apart; Ashby, in contrast, believes that the hope for linking them together is engineering. Engineers are the people who deal directly with the sciences, on one hand, and the humanities, on the other. Engineering education can, and should, involve both of these two cultures. This implies not that engineers are just applied scientists, but that we are also involved directly with social science and the humanities. The excuse often raised--that "this isn't an engineering problem; this is a political problem"--is not always valid. Most engineering problems involve political, economic, or human factors, and engineers should be educated to realize that these are the kind of problems they will often have to deal with.

My concern today is primarily with what might be called the "quality of the environment," and, of course, solid wastes are an important environmental factor. I propose to deal more specifically with environmental management and its role in determining the quality of the environment. This is particularly important in California, blessed as it is by one of the finest natural environments in the world and also in grave danger of being permanently damaged by engineers, builders, and others who are thinking of today and tomorrow--but not far enough into the future.

Simon Ramo, executive vice-president of Thompson Ramo Wooldridge Inc., said recently that the United States faces a new and critically important kind of a race, not in competition with China or Russia, but rather a race with the rapidly increasing complexity of our growing technological civilization. This is, in effect, a race between the consequences of the explosion of knowledge and our ability to control them. The outcome of the race may well be determined by whether Systems Analysis, as a discipline, "is able to grow and develop quickly enough to meet the problems of the future which we can see will be ever more pressing and difficult."

There can be no doubt about the unprecedented development of science or of its applications, whether measured by numbers of publications, the number of practicing scientists and technologists, the growth of new fields of specialization in biology, mathematics, physics, chemistry, or astronomy, or the amounts of money being invested in research. While it is more difficult to measure the rate of growth of science than to measure its magnitude, a number of approximate parameters have been suggested. One of the most imaginative of these was recently proposed by Jerome Bruner, of Harvard, in formulating what he called "Bruner's Rule"--critical changes related to the order of magnitude in years elapsed since discovery:

5×10^9	5,000,000,000	Birth of the earth
5×10^8	500,000,000	Vertebrates
5×10^7	50,000,000	Mammals
5×10^6	5,000,000	Primates
5×10^5	500,000	Present man
5×10^4	50,000	Great glacial migrations
5×10^3	5,000	Recorded history
5×10^2	500	Printing
5×10^1	50	Radio/mass education
5×10^0	5	Artificial intelligence

Paralleling the rapid development of science and technology is the speed with which world problems are developing. World population is increasing at an unprecedented and alarming rate (it is approaching 3.5 billion and is increasing at a rate of 1.8 percent annually); there are threats of famine in India and China; there is international concern about the uncontrolled pollution of air, water, and soil, about suburban sprawl and urban blight, and about the destruction of natural resources. Overshadowing all of these is the threat of nuclear extinction.

While the basic tenets of the problem posed by Dr. Ramo may therefore be generally accepted, what about Systems Analysis, the approach which he presents as a solution? It is perhaps symptomatic of the age in which we live that, in thinking of Systems Analysis, most of us immediately infer new and relatively advanced forms of mathematical analysis involving such fields as linear programming, Boolean algebra, game theory, or queuing. All of these are useful tools in the application of Systems Analysis, but, as tools, they bear the same relationship to Systems that X-rays or laboratory tests bear to medical diagnosis.

Systems Analysis, in its general sense, can be considered as a broad analytical approach to decision making; in a more limited context it is a procedure by which components (united by some form of interaction and interdependence) can be examined as a system or an assembly. It is both the art and the science by which the groups of components making up a system can be compared from the point of view of economy, efficiency, or overall effectiveness.

The development and acceptance of the Systems philosophy is an affirmative answer to the question of whether engineers and scientists are willing to take professional responsibility for the kind of world which they are creating. René Dubos has stated that it is now possible to achieve almost anything we want, so great is the effectiveness of technology based on the experimental method. Thus, he says, the main issue for scientists, engineers, and society as a whole is to decide what to do among all of the things that should be done and can be done.

The fact that we are willing and able to face the problems of what to do with science and technology could prove to be one of the most significant trends of the Twentieth Century. This trend was first recognized a number of years ago by Gilbert Murray, the eminent British classicist, who coined the term "failure of nerve." Emmanuel G. Mesthene refers to this in a recent issue of Harvard Today when he says that Murray characterized as a failure of nerve the change of temper that occurred in Hellenistic civilization around the turn of the era. The Greeks of the fifth and fourth centuries B.C. believed in the ultimate intelligibility of the universe. There was nothing in the nature of existence or of man that was inherently unknowable. They accordingly believed in the power of the human intelligence to know all there was to know about the world, and to guide man's career in it.

With wars, increased commerce, and infiltration by Oriental cultures, this classic faith was shaken; there was postulated a realm of knowledge available only to God and not achievable by human reason. Man, in other words, more and more turned to God to do for him what he no longer felt confident to do for himself. This was Murray's "failure of nerve."

In recent years we are experiencing a new-found faith in man's intelligibility, a realization that perhaps there are few, if any, inherent secrets in the universe. Our almost total mastery of the physical world offers a challenge to human intelligence of a degree heretofore unknown in history; technical mastery is being supplemented by the wisdom to harness it to human ends. Regaining confidence in human intelligence may appear to be an anomaly; at a time of increasing specialization, we are returning to the approach of the "generalist"--the development of highly qualified engineers and scientists able to understand the specialist but, at the same time, able to correlate knowledge in different fields in a meaningful and predictable way.

Systems Analysis is, then, a logical approach to the solution of complicated multi-variable problems. While this normally requires the use of sophisticated analytical tools, most of which are practical only because of the availability of the digital computer, there is considerable value inherent in the breadth of the approach, the willingness to move back from the "trees" of specialization to examine the overall "forest" that makes up the problem as a whole.

In recent years many engineers have considered engineering components (whether bridges, water treatment plants, highways, or refineries) to be ultimate objectives. While each of these may be considered as a system (or, more correctly, a subsystem), their examination as an integral part of the broader community system may provide surprising benefits. For example, the Northeastern Illinois Metropolitan Area Planning Commission, in analyzing sewage, refuse disposal, and municipal water supply problems in the Chicago metropolitan area, looked for the first time at the broad interrelationships between these facilities and the metropolitan area as a whole. The impact of this study was dramatic; it indicated surprising deficiencies in some instances, and duplication and overlapping in others. It was evident that although each facility had apparently been well designed from the limited point of view of the single project, the metropolitan area itself was served ineffectively.

The recently published National Academy of Science-National Research Council Report "Waste Management and Control" emphasizes the importance of Systems Analysis. Quoting from this significant review of the waste problem, the report states:

> There is increasing acceptance of the argument that a systems approach to urban and regional pollution problems has become imperative. The present complexities of environmental problems and the knowledge that, as time goes on, these issues will become even more complex and interrelated makes this conclusion inescapable.

> . . . Analyses undertaken for such systems can provide the information required for action today, and will furnish invaluable leads to the research needed to provide the bases for tomorrow's programs. . . .
>
> The systems approach must consider the interrelationships of land, air, and water. Too often municipalities get rid of solid wastes by incomplete burning, which may solve the land disposal problem but fouls the air. We must consider the assimilative capacity of water, air, and land taken together as a single entity and in relation to the plants and animals that live there.

The techniques of solid-waste disposal (which receive the majority of attention from engineers) are, in fact, a relatively minor part of the overall waste disposal problem. Adequate plans for the future obviously cannot be made without a consideration of collection, disposal sites, conservation, reclamation, esthetics, soil, and water and air pollution. We often create more problems than we solve if decisions are made based on only one or two of these considerations.

In the field of biology, microphotographs or enlargements of one small section of a plant or animal may provide no indication or clue to the overall picture. It is axiomatic that knowledge of the "whole" provides a better understanding of the detail being examined, and that examination of the detail, in turn, provides a better understanding of the whole. Quoting again from the National Academy of Sciences-National Research Council Report:

> Pollution in the biological sense is the introduction of antibiotic elements into the resource cycle. "Antibiotic" means something able to stop completely, to control, or to direct biological activity. A "resource cycle" is the turnover of elements in the ecosystem. And the "ecosystem" comprises the interacting, living and nonliving, elements in a particular habitat.
>
> The dynamics of the ecosystem imply the presence of living and nonliving elements; they also imply the presence of resources, some derived from the atmosphere and some from the substrata (the soil and the water). The rate, the quality, and the quantity of supply in a given habitat or

ecosystem are governed by factors, some of which are very remote, such as light-periods, rainfall, radiation from outer space. There are various degrees of remoteness in the conjunctional factors that finally permit a certain amount of turnover of the resources which are cycled through the body of the living organisms, whether plant or animal.

Turning again to engineering, there is a logical argument that engineering education is now taught backward. Most of the time that is available for undergraduate study is spent in developing an effective background of mathematics, science, and engineering science in order to design components. This leaves the graduate with the idea that engineering consists essentially of the design of bridges, turbine blades, electronic switching gear, or more effective evaporation columns. But, by the time that it has been decided to build a six-lane steel bridge across a given river, most of the engineering work has already been done: the decision that the bridge is necessary; its location; its effect on regional and city planning; its type; its size; its economic feasibility. A broad systems understanding of engineering puts these problems in their proper perspective; a consideration of engineering systems (objectives, criteria, and professional responsibility) should therefore precede component design in the educational plan rather than follow it, as is present practice.

A new and growing phase of Systems Analysis has been referred to as "Systems Evaluation." This is a consideration by analytical means of alternative methods for the solution of problems, taking into account not only existing technology but new approaches. This approach, widely publicized by the Department of Defense Weapons Evaluation Group, has equal validity in the Public Health Service, the Corps of Engineers, or industrial organizations. Such a group should consist of a core group of analysts (with various backgrounds) responsible for evaluation of a variety of approaches to the problem, the alternatives, and the consequences.

It would be grossly unfair to infer that Systems Analysis in the generally accepted sense can be represented solely as a philosophy. Most of the research, the publications, and the practical applications of Systems Analysis involve a high level of mathematical sophistication and extensive use of computers. This has made it possible to critically examine a wide range of alternative solutions to a given problem and has put a new and much-needed emphasis on such problems as social costs, social benefits, and cost comparison, and has in many instances pointed the way to priorities for research and investigation.

If we are not to march blindly ahead into a chaotic world of uncontrolled application of scientific discovery, professional responsibility must be assumed not only by politicans and statesmen but by scientists, engineers, agriculturists, and physicians. While no one has suggested a rigid control of the direction of scientific discovery, we must encourage the growth of qualified generalists, the systems analysts, able to evaluate alternatives and thus help to guide technology in shaping the world of tomorrow.

In conclusion, in the reference in Professor McGauhey's paper to the difficulty of attracting high-school students to engineering schools to work in the solid-waste field--I have had the same experience. It is difficult to get a group of high-school students excited about sewage treatment or about composting or about landfill. But I have found that these same students can be very challenged, very excited, very much interested in the possibility of using their ability (particularly if it is an analytical type of ability) in helping mankind create a better world in which to live. In other words, if we talk about environmental control, about environmental management, instead of talking specifically about the technological solutions involved, I am confident that we can continue to attract the brightest of our young men and young women into this extremely important field, and that they (particularly if we introduce the systems approach) can provide the leadership in shaping the kind of world that we want in the years ahead.

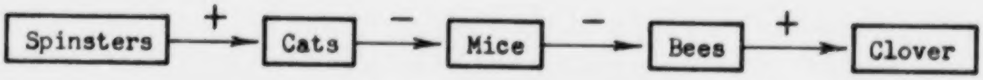
Spinsters
+
Cats
−
Mice
−
Bees
+
Clover

Fig. 1 Open-end block diagram

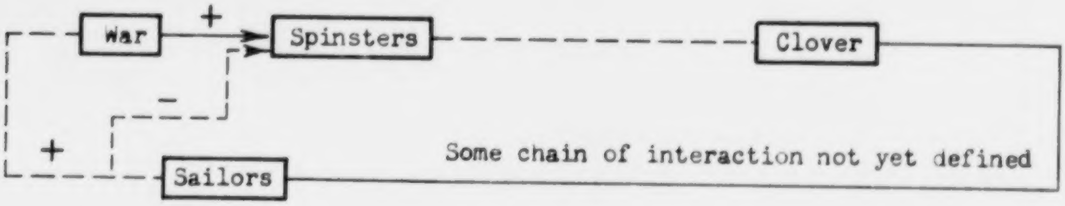
War
+
Spinsters
Clover
−
+
Sailors
Some chain of interaction not yet defined

Fig. 2 A hypothetically elaborated system to develop a closed-loop block diagram

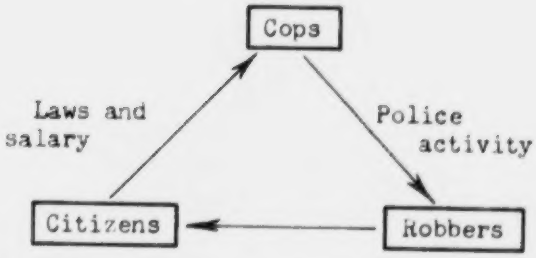
Cops
Laws and
salary
Police
activity
Citizens
Robbers

Fig. 3 Simple closed-loop block diagram

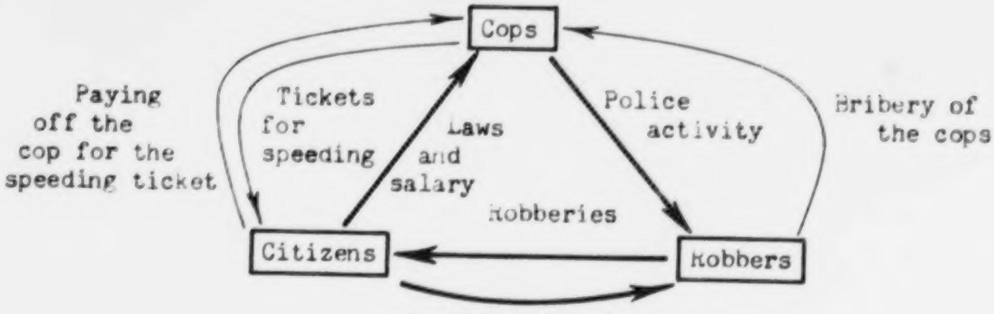
Cops
Paying
off the
cop for the
speeding ticket
Tickets
for
speeding
Laws
and
salary
Police
activity
Bribery of
the cops
Robberies
Citizens
Robbers
Gambling, betting

Fig. 4 Elaborated system block diagram with alternate interaction

UNDERSTANDING THIS NEW APPROACH

Dr. A. A. Brown

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Dr. Brown is a pioneer in operations research. During World War II the U. S. Navy assembled one of the first teams of operations research personnel; Dr. Brown served on the team and became associate director. He has also served as executive secretary for the National Research Council's Committee on Operations Research. He is a founding member of the Operations Research Society of America. He has been associated with Arthur D. Little Company since 1952.

I am down on the menu for today as something like fried Loch Ness monster --a dish that is improbable in itself, and not necessarily appetizing. I'm supposed to talk about systems analysis in nonmathematical terms. I don't know whether it can be done, but we'll have a try--and, hopefully, within 45 minutes everybody here will be his own systems analyst. From what I know of systems analysts, that should lead to a great many arguments.

This field of systems analysis is rife with a very large number of what I call "buzzwords." You can't say "hello" in systems analysis--but you can discuss parameters, you can discuss ecological subsystems and hierarchical oversystems, and so on, until the air is thick with verbal smog; yet, under it all there is something that can be of great value. I've got to steer a very careful course between being or sounding like a "phony," on the one hand, and failing to give you some idea of what systems analysis is all about, on the other.

As I see it, my job today is not to make any suggestions as to how to manage a solid-waste program. I couldn't; I don't know anything about the management of solid wastes. It's not really my job to deal with systems analysis in the specific area of waste management; rather, I am to tell you how to get along with the people who do systems analysis, so that those of you who are in the waste management business can get some help from some fairly difficult people.

So let me try to describe what it is that a management scientist or a systems analyst or an operations research type is up to, how he goes about it, and how you can deal with him so that you can get the best from the kind of work that he can do. Really he has just one job, and that is to create a useful, formalized description of the system which is being analyzed. I say it should be formalized because formalization means that the thinking and the underlying assumptions are brought out into the public domain where they can be argued about, where they can be beaten into shape, where they can be made useful. In some ways, the job of making up a description of this sort, a formalized description for public debate, is something that only a masochist can enjoy. You take a terrible beating the moment you lay down a theory, because you have stated quite clearly what you're thinking and everybody can see how wrong it is, and will tell you so immediately. The best you can do is to ask him to expound his own theory, and then, if he does, you can whack back at him.

These systems people that you will be dealing with are not the ones who actually carry out the executive job or the management job, yet they're trying to advise you on how to do a job that you know very well how to do. They are trying to lay down some suggestions for operation in a field in which they don't really know their way around, in which they don't know the answers, and they're trying to provide a way of looking at it that, on the face of it, probably doesn't seem to make much sense.

While I was looking around the city of Davis this morning for some typing paper, I wandered into a stationery store, where I saw a large Picasso coloring book. Picasso, a few years ago, put forth in his paintings what amounted to a theory of vision or visual perception, which in his time was revolutionary, yet now we have for five-year-old children a Picasso coloring book--and the next generation that comes along may well see things as he saw them. This suggests that when you're dealing with the systems analyst, who is also attempting to see things in new ways, you should have patience, you should try to understand what he is up to, make the best of what he offers, and try to translate it into action.

In order to illustrate some of these things, let's go away from the field of waste management and take something that neither of us knows much about. That way we can see things much more clearly than if we really know the facts. Let's start the illustration by considering Fig. 1, a block diagram. This is the systems analyst's coloring book, really. The first example in the systems analyst's coloring book is taken from Charles Darwin, and it deals with the ecology of old maids, cats, mice, bees, and red clover. You start the system at the left of the figure, with a pool of spinsters. These spinsters act on the cat population in such a way that, the more spinsters there are, the more cats--because they like cats and they keep them. The cat population acts on the mouse population with a negative sign because cats catch mice. The mouse population acts on the bees negatively because mice eat bees. Bees act on the clover population with a plus sign because they help in pollination. So the ecological chain goes: the more spinsters, the more cats; the more cats, the fewer mice; the fewer mice, the more bees; the more bees, the more clover. In sum, the more spinsters, the more clover. This is elementary systems analysis.

This is what we call an open-ended system, in that the amount of clover doesn't react on the number of spinsters; and it is an incomplete system in that there is no input to the spinster group and no output from the clover group. The example was taken from a society, namely 19th century England, at a time when, possibly, the number of eligible bachelors had been decreased by foreign wars; you could, if you want to, put down in a new diagram a war-spinster link with a plus sign, i.e. war increases the number of spinsters (Fig. 2). Now, if you could then begin to connect the output of clover to the likelihood of war by some chain or other, you see you would have a closed loop. There are other ways to close the loop; for example, sailors to marry the spinsters, linked to the clover output. I hope you'll understand; in a coloring book you can do many things that you couldn't do in real life. Suppose, now, that sailors are allergic to clover, and, the more sailors, the fewer spinsters. Then you close the loop; the system takes on a life of its own, with a complex effect on each of its components.

The chain of causality that I have sketched in is purely qualitative at this stage. It's quite useful in a systems study to make out one of these at the start, and all you need for it is a broad brush. Sketch the boxes and arrows roughly, so as to free the imagination; don't try to think too clearly at this stage. What you want to do is to get everything that you can think of into the chain. For example, we've shown here that the spinsters keep cats, and that the cats catch mice; but, if they feed the cats too much then the cats don't catch mice; so, ultimately, you've got to separate out the spinster population into good cooks, or good cooks for cats, and not-so-good cooks for cats, etc. But not to begin with.

So, in a systems analysis of waste management, then, you want to start with a qualitative chain something like this: people create waste. This is as much as I know about solid-waste management. But even this may provide some qualitative view. The more waste, the fewer people, possibly. You can imagine that, some time in the future, when the population is high enough, even "boy-meets-girl" gets to be very difficult because, while he's trying to chase this girl, he trips over the waste bedsprings and old automobiles and he can't catch her, so that we get fewer people and we come to an equilibrium point at which there's only just so much waste to be disposed of, enough to hinder procreation but not to abolish it.

You don't end the analysis just by drawing a diagram with plus and minus signs. Once you've got the system laid out qualitatively, you need some experimental observations. For example, how many cats does a spinster keep? Perhaps you get a Gallup poll going, and you find out that there is some coefficient (what we call a parameter) which shows that there are 2.3 cats per average spinster. What is the size of the mouse population with respect to the cat population? Well, if there are $\underline{M}_1$ mice and $\underline{C}_1$ cats, your good systems analyst will write down some sort of equation showing that the number of mice is a function of the number of cats, and then, if he's been trained in ecology and calculus, he will differentiate the function and tell you how much of a decrease in the mouse population will arise from an increase of one cat in the neighborhood.

Similarly, you have to relate the number of bees to the number of mice, the size of the clover population to the number of bees, etc.; you have reached the empirical, or empirico-quantitative, phase of your systems-analytical work. Once you've got all your equations built up, you may be able to solve them mathematically, or you may have to throw the whole system into a computer for simulation.

Let's look at one more example of qualitative systems analysis. Figure 3 shows a game of cops, robbers, and citizens. This game ought to give a great deal of room for speculative systems analysis because I know as little about this field as you probably do. The general view is that the cops act to decrease the number of robbers, and what they get from the citizens is pay, i.e., the citizens support a police force on the one hand, and they also pass some laws with which the cops act on the robbers, and all that the robbers do is employ force against the citizens. Therefore, in order to decrease the number of robbers, we'll increase the severity of laws, increase the police force, and thus cut down the number of robbers, and pretty soon it comes to the point where the loss from this robber force is balanced out against the cost. By a simple economic analysis, you decide that you've now got a big enough police force, you're paying enough for it, the number of robberies per year has gone down to the point where if you paid the police force more you would lose more than you lose by the amount of robbery that goes on; and so you say, "Well, we've reached the equilibrium state; we'll put up with the stolen cars and so forth, and save money on our taxes." On the other hand, we know, or strongly suspect that there is at least one crooked policeman somewhere in the country. Figure 4 shows how Fig. 3 can be more complicated. Thus, we show, in principle, a counterflow of money, from the robbers to the cops; that is, there is a flow of money from the citizens through two channels, one direct to the police and the other to the police through the robbers. But the robbers don't live only on income derived from using force; they also supply some sort of gratification to the citizens, say through off-track betting or by providing some illicit pleasure or other, and there is a counterflow of money to match the flow of gratification. The police also pinch you for overparking and you pay off either in the courts or a little more directly. Now, the moment you start to draw in these extra channels (and, you see, all you need is one instance to establish the principle) you establish the existence of the corresponding flows. This is the advantage of using a very broad brush to draw in all possible channels. You then ask a quantitative question: How much? Is this a serious problem or is it not? You have to ask yourself: If we increase the severity of the laws, what happens? Well, the repressive effect goes through the cops, so that the price of protection goes up. This means that there has to be more money in the payoff pool, which has to come from the citizens, so the number of robberies goes up in order to pay off the police to make it safe to commit the burglaries, and the price of betting or dope or whatever it is that the robbers are selling to the citizens goes up, too.

I'm really trying to show you what a systems analyst does, which is to suggest some possibly shocking descriptions of the world. But that's his job; he's not supposed to take things as they are, he's supposed to try to see the realities underlying them. By putting in a channel like this which shows that some cops get paid off, he does raise the question: How much and what's the relationship of this payoff to the amount of threat that the policeman holds? Therefore, what's the relationship of this payoff to the severity of the laws and what's the relationship of the severity of laws and this payoff to the crime rate? And the systems analyst's job is to make this as complex as it probably really is.

I'd like to suggest a few publications that you very well might want to read in this connection.

One is the May, 1965, issue of the Journal of the American Institute of Planners. This has an excellent article by Ira Lowry, called "A Short Course in Model Design." I recommend it with essentially no reservations; at least, the reservations I have are not worth taking up here. It's a very good article. Lowry discusses the uses of models--as descriptive, as predictive, and as of use in planning. He discusses the strategy of model design, treatment of time, the concept of change, relating models to facts via observation and statistics, the use of computers and simulation.

You will be reading the second publication, the Aerojet-General report, as a matter of course.

The third text that I want to recommend is Charles Hitch's "Decision Making for Defense," published by the University of California. In this book Hitch discusses the whole system that he and Robert McNamara set up in the Department of Defense. He gives the basic reasons why that system was necessary and outlines its main features. For today's purposes we ought to consider just two aspects of what Hitch has to say. First, a definition of what a program is. A program, as Hitch uses the term, is a cross-departmental activity. When Hitch and McNamara came into the Pentagon they found three separate services (which correspond to administrative departments really), each with its own technical, fiscal, and personnel requirements. But these three services were supposed to interact in the interests of the country and to support each other. The notion of a program was developed just to give some reality to this interaction. Hitch and McNamara defined nine major programs: strategic retaliatory forces, continental defense forces, general-purpose forces, air lift and sea lift, reserve and guard, research and development, general support, retirement pay, and military assistance. These, you see, cut right across the military divisions between Army, Navy, and Air Force. They are functional divisions, and I want to suggest that you should think seriously, in connection with waste management programs, how the whole subject of waste management fits into city, state, and national administrative departments. I'm sure that it doesn't belong solely in an administrative area called waste management. It bears on community health, on community progress, on community finance, on community development to the extent that you can carry out sanitary landfill and create livable areas, and it bears on the housing problem, the transport problem, and so on. That is, it would seem to be very much worthwhile to take this concept of a program as developed in the military area and to transfer this notion to community planning to see what kind of programs are needed in the civilian area. I don't pretend to have an idea of what they should be, but the concept is certainly worth applying.

Hitch has a very good--and I think quite complete--discussion in his book on the concept of a program, and I recommend it very strongly.

The second portion of Hitch's argument that I'd like to discuss is his view of systems analysis. He says, "It is my experience that the hardest problems for the systems analyst are not those of analytic techniques," and this is what I'd like to get to today. You can rely on the systems analyst, on the people who are supposed to be helping you, to provide the mathematics. If they can't, fire them and get somebody who can. This, you should be able to count on from them; you do not have to provide it yourself. Hitch says, "In fact, the techniques we use in the office of the Secretary of Defense are usually rather simple and old-fashioned. What distinguishes the useful and productive analyst is his ability to formulate or to design the problem, to choose appropriate objectives, to define the relevant, important environments or situations in which to test the alternatives, to judge the reliability of his cost and other data, and finally and not least, his ingenuity in inventing new systems or alternatives to evaluate."

So, when you are working with these people I think this is the point you want to stick with. Let them do the mathematics and insist that they discuss with you and develop with you the problem definition, the definition of the environment, and the determination of which lines of research, which lines of study, are the fruitful ones. While you're dealing with systems analysts--I want to go back to what I said at the beginning--you'll find that some of their suggestions are either difficult, impractical, or apparently irrelevant. I want to suggest that you don't dismiss these suggestions out of hand, but take time to explore them to see where they can take you. Suggestions from that sort of man are quite different from the "bee-in-the-bonnet" suggestions that you can pick up in any luncheon conference. I'm sure that, with a five-minute acquaintance with the problem of solid-waste management, I could give you sixteen answers on what to do--none of them any good. And that is not what we're asking the systems analyst to do. He is not to come up with answers, but to come up with analyses, to draw block diagrams, to draw circuit diagrams, to suggest variables for measurement, to suggest ways of measuring those variables, to suggest interconnections between them, and to provide to you ways of understanding the problem and ways of connecting all the variables together that can be helpful to you.

As I said at the outset, this talk was something of an impossibility. If it was something like fried Loch Ness monster, I'm sorry; I hope it doesn't give you terrible indigestion.

APPLICATION OF THE APPROACH
The California Waste Management Study

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Mr. Jackson is a mechanical engineer by academic training, and an all-around project engineer by assignment. He has been department manager of Life Support Systems Division of the Von Karman Research Center of the Aerojet-General Corporation.

Aerojet-General was the successful bidder for the waste management study awarded by the State of California. Mr. Jackson was the project manager for this study, so brings us first-hand knowledge of systems analysis and waste management.

Introduction

Aerojet-General Corporation is not really in the waste management field, although there have been some products which relate to waste processing and disposal. Some examples are the reverse-osmosis water-treatment unit built by our Chemical Products Division, the industrial plants planned by our AETRON Division, and, of course, the solid waste that we have helped deposit in orbits around the earth.

We are keenly aware that the success of any project depends on a comprehensive knowledge of applicable technologies. During the waste management study we conducted an extensive literature survey, which demonstrated to us the complexity of waste management and the wealth of current technology being employed in solving today's problems. We realize that the creation of advanced systems of the future depends upon the knowledge and techniques of the waste management profession. We can only suggest an approach that the profession can exploit in creating these future systems.

Now, the primary topic of this discussion is not solid waste nor a review of the contents of the California Waste Management Study Report. Rather, it is a discussion of the approach employed in that study.

An outline is shown here (Fig. 1). The purpose of the Waste Management Study will be stated and the systems approach briefly described, then we will consider the systems approach as applied to the waste management field and the Waste Management Study. The conclusions of the study will be reviewed and the recommendations summarized.

The study had the purpose of providing information that would facilitate future action by the State in the field of waste management. It was necessary to identify analysis methods, inhibiting factors, and the first steps to be taken in a comprehensive effort of air, land, and water quality control. It was the purpose of the study to assess the applicability of the systems approach to waste management.

The Systems Approach

At the outset, it may be helpful to define what is meant by the "systems approach" in this discussion. The three principal steps or phases of the basic systems approach are illustrated in Fig. 2. These are:

1) Define the problem in terms of requirements
2) Determine the functions for satisfying these requirements
3) Translate these functions into distinct operations.

These three phases encompass the overall consideration of various means of accomplishing the desired results. The approach embodies the concept that each system is an integrated whole even though composed of diverse and specialized subfunctions. The primary objective is the success of the system rather than the optimum performance of any part.

Figure 1

OUTLINE

I PURPOSE OF CALIFORNIA STUDY

II THE SYSTEMS APPROACH

III THE SYSTEMS APPROACH APPLIED TO WASTE MANAGEMENT

IV CONCLUSIONS

V RECOMMENDATIONS

Figure 2

THE BASIC SYSTEMS APPROACH

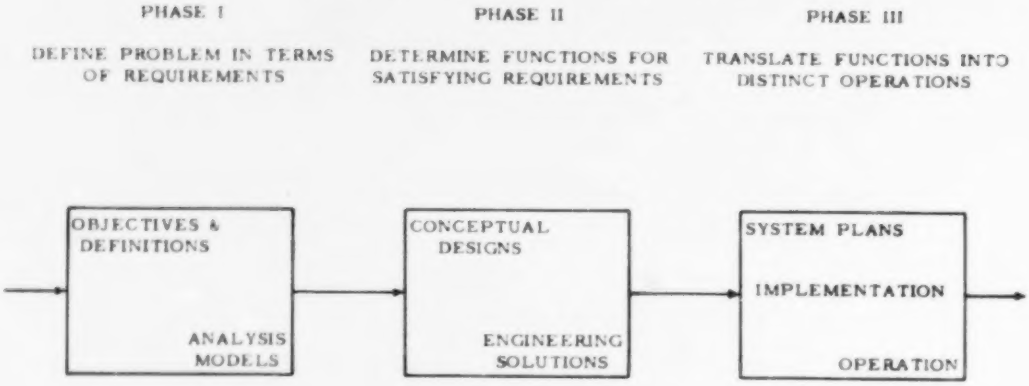
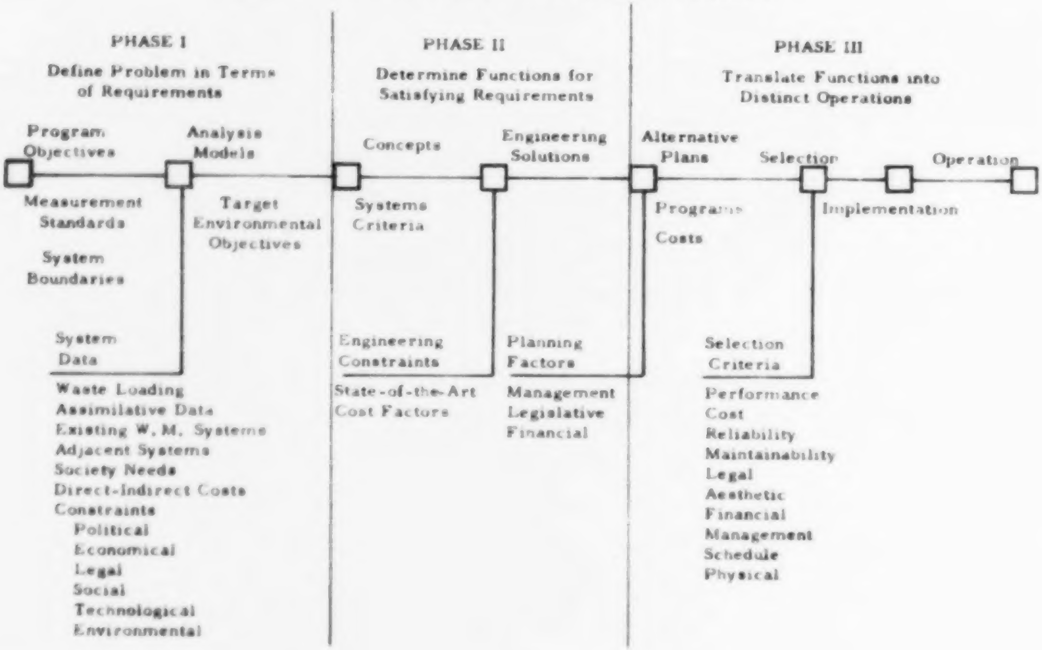

PHASE I
DEFINE PROBLEM IN TERMS OF REQUIREMENTS
PHASE II
DETERMINE FUNCTIONS FOR SATISFYING REQUIREMENTS
PHASE III
TRANSLATE FUNCTIONS INTO DISTINCT OPERATIONS
OBJECTIVES & DEFINITIONS
ANALYSIS MODELS
CONCEPTUAL DESIGNS
ENGINEERING SOLUTIONS
SYSTEM PLANS
IMPLEMENTATION
OPERATION

Figure 3

A WASTE MANAGEMENT SYSTEMS APPROACH


PHASE I
Define Problem in Terms of Requirements
PHASE II
Determine Functions for Satisfying Requirements
PHASE III
Translate Functions into Distinct Operations
Program Objectives
Analysis Models
Concepts
Engineering Solutions
Alternative Plans
Selection
Operation
Measurement Standards
System Boundaries
Target Environmental Objectives
Systems Criteria
Programs
Costs
Implementation
System Data
Waste Loading
Assimilative Data
Existing W. M. Systems
Adjacent Systems
Society Needs
Direct-Indirect Costs
Constraints
Political
Economical
Legal
Social
Technological
Environmental
Engineering Constraints
State-of-the-Art Cost Factors
Planning Factors
Management
Legislative
Financial
Selection Criteria
Performance
Cost
Reliability
Maintainability
Legal
Aesthetic
Financial
Management
Schedule
Physical

On large and complex systems, it is necessary to conduct an intensive analysis of the basic requirements: such as reliability, cost, performance, and maintainability. Parametric analyses are conducted in which analytic models of the system are developed, and the interrelated variables are studied to assess their effect upon over-all system objectives. Ultimately, the process involves the development of plans, and acquisition and operation of the system.

Certain computation and experimental techniques have been associated with the systems approach. Tools used in the application of these techniques are digital and analog computers, modeling, simulation, and the employment of statistics in system design. These are used in projecting a system's performance or in determining other attributes instead of building and testing the real thing.

The Systems Approach Applied to Waste Management

Now how might this approach apply to a waste management system? Figure 3 summarizes the answer. The three phases of the systems approach are expanded to reveal some of the steps involved in developing a waste management system.

During Phase I, one of the first steps is to establish the program objectives and standards of measurement, and to identify the boundaries in which the system is to operate.

Next, system data involves the collection and correlation of information relative to existing conditions, and provides the data required in making predictions of system functions. It includes information in regard to waste loading, existing waste management systems, methods of estimating a direct cost of system acquisition and operation, and the methods of determining the indirect or social costs resulting from waste management practices. Certainly, such information as political, economic, and legal constraints need to be considered in establishing all of the requirements for a waste management system design.

In Phase II, on examination. many theoretical solutions (concepts) are developed which are subsequently refined and reduced to a smaller number. Engineering solutions are developed which satisfy the remaining concepts.

As an example, the concept in the case of liquid-waste disposal may be one which embodies changing the assimilative capacity of a lake, while an engineering solution satisfying this concept might be one in which the assimilative capacity is expanded by augmented flow or through intensification of the biological action occurring in the lake.

While Phase II may begin with a conceptual design, it terminates in a definition of the system that satisfies the particular requirement(s). Definition of the system requires that: 1) basic functions be identified and related to each other; and 2) means of performing these functions be desired, compared, and selected. Numerous trade studies are required to determine the means to be employed for each function, in addition to selecting the functions and their sequence.

For a complex system which may operate in a fairly large geographical area, it will be necessary to develop extensive plans for acquiring and finally placing the system in operation, as illustrated here in Phase III. In addition to alternative engineering solutions, there can be alternative plans whose features may more nearly satisfy factors other than system performance or cost. These factors could include time required for acquisition, legal considerations, methods of financing, and the kind of management to be applied in carrying out the plan or in operating the system.

All of these steps involve monitoring and feed-back where necessary. As an example, the final engineering solutions that are developed in Phase II are examined and compared with the system criteria. Another example is that the target environmental objectives established for the system are reviewed to see whether they satisfy the overall program objectives established during the initial part of Phase I.

All phases are related to each other in terms of the ultimate purpose. This ultimate purpose is established by anticipating the outcome of Phase III, an operating system. Thus, the data and information formulated in Phase I must have a form and content that will be useful in subsequent phases.

This description of the basic system steps as applied to a waste management system is simplified considerably for the purpose of presentation. In reality, each step is extremely complex, requiring many man-years of effort. Certainly, a time span of more than six months would normally be required to complete even the first phase. Consequently, the study was directed to the exploration of these basic steps as applied to waste management.

Waste Management System

One of the first questions to be answered, at least qualitatively, is--what must the system do?

To do this, one must clearly establish the input and output boundaries of the system. This definition may seem obvious to some, but proper application of the systems approach requires that it be carefully stated (Fig. 4).

On the left-hand side of the diagram, an input boundary is indicated which is downstream from the waste generator. It is at this point that the waste management system begins when the waste is discarded. This boundary location limits the control that waste management may exercise on other activities in society, although it is recognized that the waste management system has the responsibility of reporting to the waste producers the cost incurred in processing and disposing of waste. A requirement is generated for analysis of the effect of waste composition and quantity on the waste management system, and the computation of charges to waste producers for waste disposal.

The output boundary occurs on the environment. A definition of a waste management system which included activities beyond this point (i.e., people, industrial activities, esthetic enjoyment, land utilization, marine life, agricultural activities) would require that waste management be concerned and become involved with controlling and learning about the behavior of all of these follow-on activities. No clean line of responsibility could be spelled out for the waste manager. However, the point chosen is definable and limits responsibility and authority in a waste management system.

Two major outputs of the waste management system are shown on the chart. One output is the environment as affected by pollutants, and the other output is materials which have been reclaimed from waste and can be returned to use.

The output defined by the environmental objectives needs to be specified by the follow-on activities since they are the ones affected by operation of the waste management system.

Generally, there are no definitive specifications in regard to environment objectives. This condition is one of the principal hindrances to analysis and development of a waste management system.

Figure 4

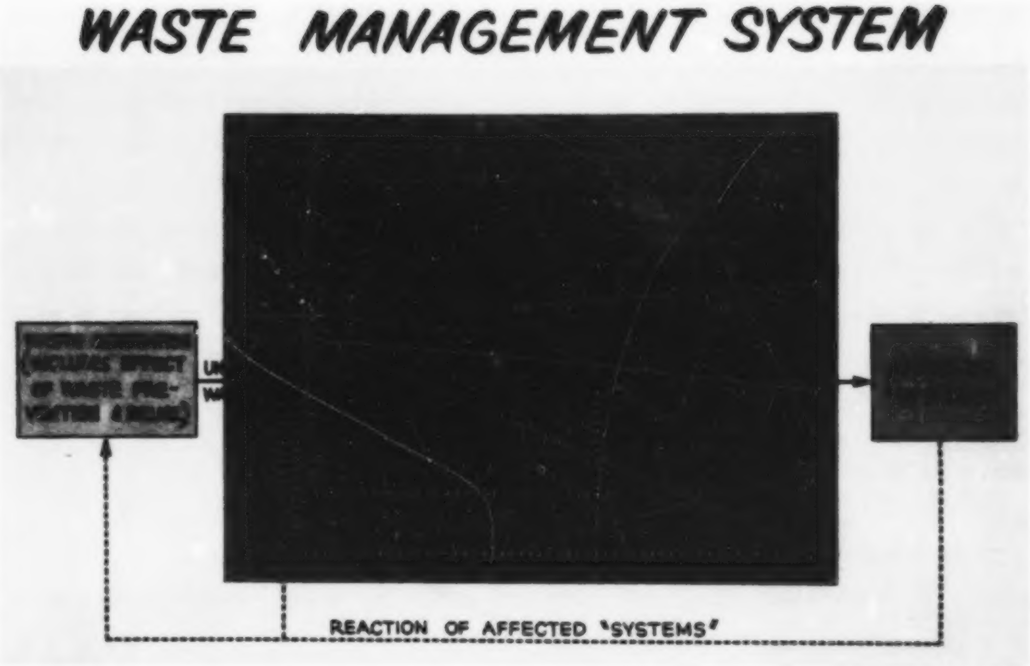
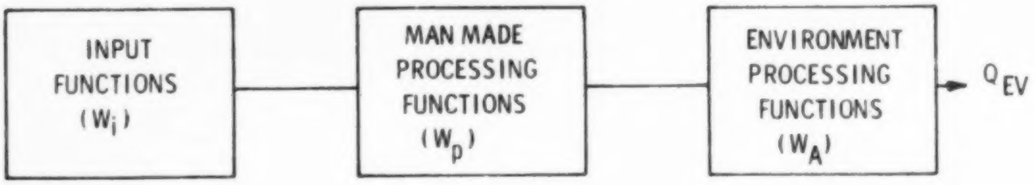

WASTE MANAGEMENT SYSTEM
REACTION OF AFFECTED 'SYSTEMS'

Figure 5

WM SYSTEM ELEMENTS

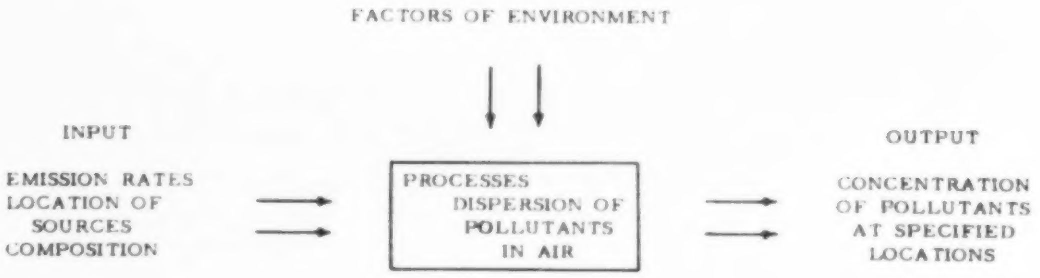

INPUT FUNCTIONS (W_i)
MAN MADE PROCESSING FUNCTIONS (W_p)
ENVIRONMENT PROCESSING FUNCTIONS (W_A)
Q_{EV}

Q_{EV} = ENVIRONMENT POLLUTION LEVEL

= $f(W_i, W_p, W_A)$

Figure 6

AIR QUALITY MODEL


FACTORS OF ENVIRONMENT
INPUT
EMISSION RATES
LOCATION OF SOURCES
COMPOSITION
PROCESSES
DISPERSION OF POLLUTANTS IN AIR
OUTPUT
CONCENTRATION OF POLLUTANTS AT SPECIFIED LOCATIONS

Feed-back loops are indicated by the dashed lines. Control of the system to the specified value is provided: additional feed-back influences the waste generators by reactions of the follow-on activities.

As shown in the chart, certain functions constitute the waste management system--collection, transport, processing, disposal, and reclamation. The environment is employed in many ways to dilute and change waste, as indicated by the term "environmental assimilation."

For the purposes of analysis the system can be divided into three elements: 1) input; 2) man-made processes; and 3) environmental processes. An extremely simplified relation which expresses environment pollution as a function of these three principal elements is shown in Fig. 5.

Elements of Waste Management System

These elements are:

1) $\underline{W}_i$, the input function, characterized by waste composition and distribution
2) $\underline{W}_P$, man-made processing facilities, which are affected by rate and composition of the waste
3) $\underline{W}_A$, the environment's capacity to dilute and change waste through natural processes.

Pollution level in the environment is also a function of time, and varies with interrelated actions of the three main elements.

In order to conduct a systems analysis which takes into account the many interrelated, variable, and complex functions that are characteristic of a system, it is necessary to be able to describe and manipulate these functions in quantitative terms. Short of constructing and testing actual systems for evaluation, this can best be accomplished by analytic models that are mathematical or analog representations of the actual elements. A very simplified analytic model that was formulated during the study is represented in Fig. 6. In this case, the problem was to determine pollutant concentration in a large air mass as a function of location. Simply, the model consists of: 1) input quantities; 2) relations which describe the processes that go on when airborne wastes are mixed with air; 3) output quantities which are the desired results; and 4) those factors of the environment which may affect the processes such as wind velocity and solar irradiation.

Figure 7

BASIS FOR AIR QUALITY MODEL

- GAUSSIAN PLUME FORMULA
- GRID COORDINATE ANALYSIS

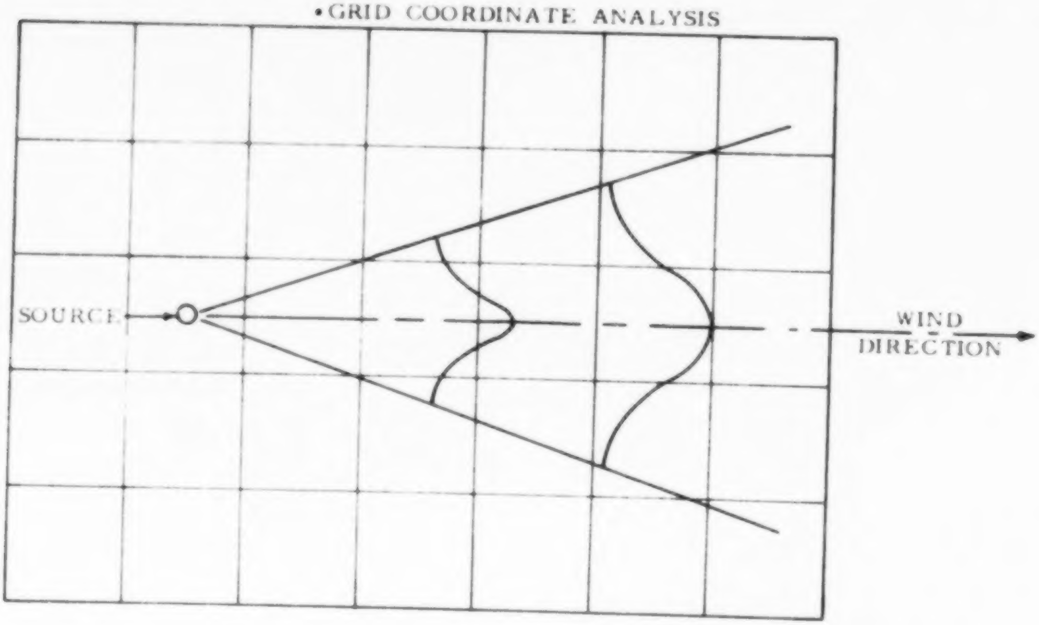

SOURCE
WIND DIRECTION

Figure 8

OXIDES OF NITROGEN CONCENTRATION (PPM) EXPECTED TO BE EXCEEDED ON 3% OF THE DAYS IN 1965

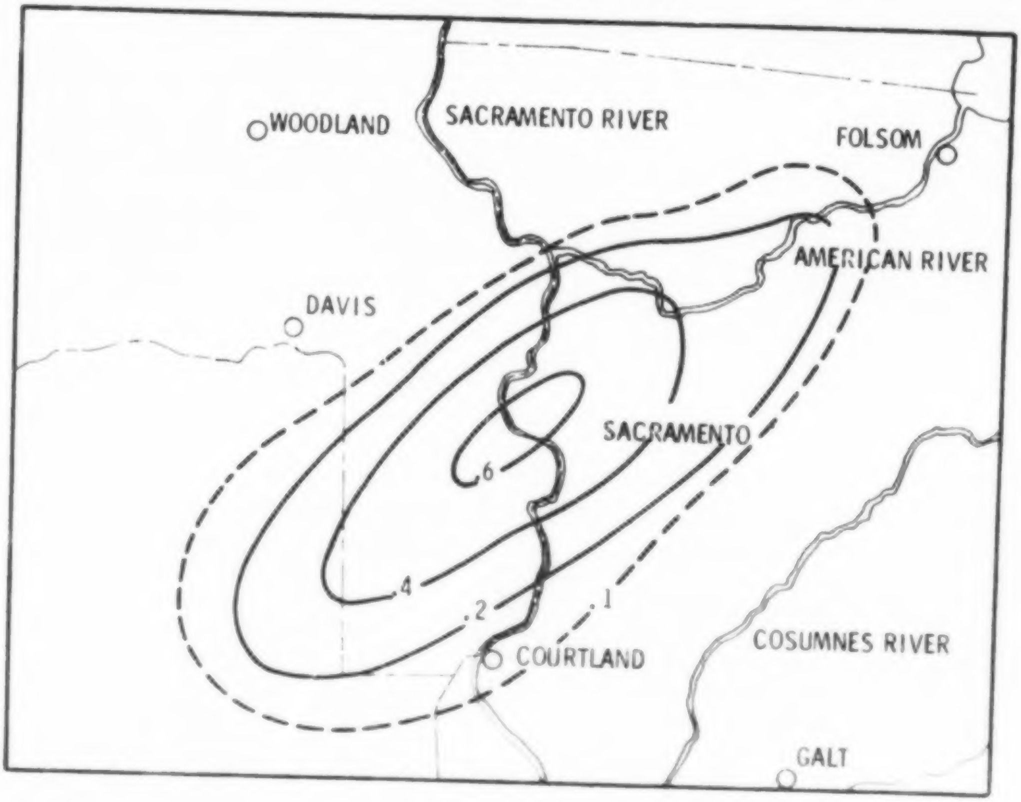

WOODLAND
SACRAMENTO RIVER
FOLSOM
AMERICAN RIVER
DAVIS
SACRAMENTO
.6
.4
.2
.1
COURTLAND
COSUMNES RIVER
GALT

Figure 7 reveals the basic relation that was employed in the air-quality model. Pollutant dispersion from a source was represented by use of generalized Gaussian Plume Formula. A grid coordinate system was set up over the geographical area of interest, and, in order to simplify the mathematics, one axis of this grid was made parallel to the wind direction. By computing the concentration at all down-wind grid squares, and adding these contributions, it was possible to determine the pollutant concentration throughout an area.

Examples of predicted air pollutant concentration for the Sacramento area are shown in Figs. 8 and 9 for the years of 1965 and 2010 at one reference weather condition.

The significant point to be made is that a model, in conjunction with a computer, permits one to simulate a variety of conditions that may happen and thus discover the interrelations and significant effects of the many variables. For instance, application of an air-quality model to an area will reveal the effects of proposed industrial plants and freeway confluencies on air quality at points far removed from the emission site. Values of the input parameters can be changed on paper, and the effects of these changes on air quality conveniently determined with the basic model.

During the study, it was found that analytic models of specific water sheds and air "sheds" have been developed, including analytic models of tidal basins and estuaries. Air pollution models have been prepared by the Public Health Service as adapted from previous work by the Atomic Energy Commission.

Similarly, water-basin models have been or are being developed by the University of California and the Delaware River Commission, to mention two examples.

The investigation of modeling which would simulate the environmental functions of the waste management system revealed that, although the processes are complicated, there is a sufficient technology to proceed with the application of such models to large basin areas such as the San Francisco Bay and Delta Region. In fact, work along this line is currently in process. Although the extensive type of modeling necessary could not be performed in the limited study effort, the requirements for such models were recognized and it was found technically feasible to apply them to large air masses and to large water-basin areas.

Figure 9

OXIDES OF NITROGEN CONCENTRATION (PPM) EXPECTED TO BE EXCEEDED 3% OF THE DAYS IN 2010

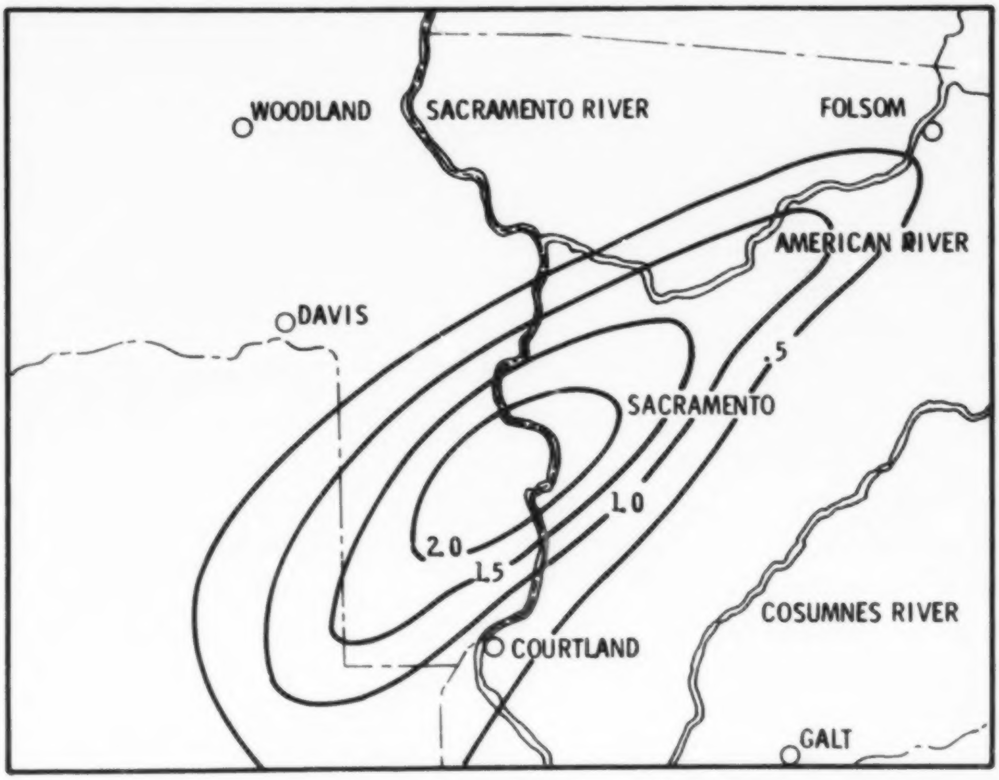
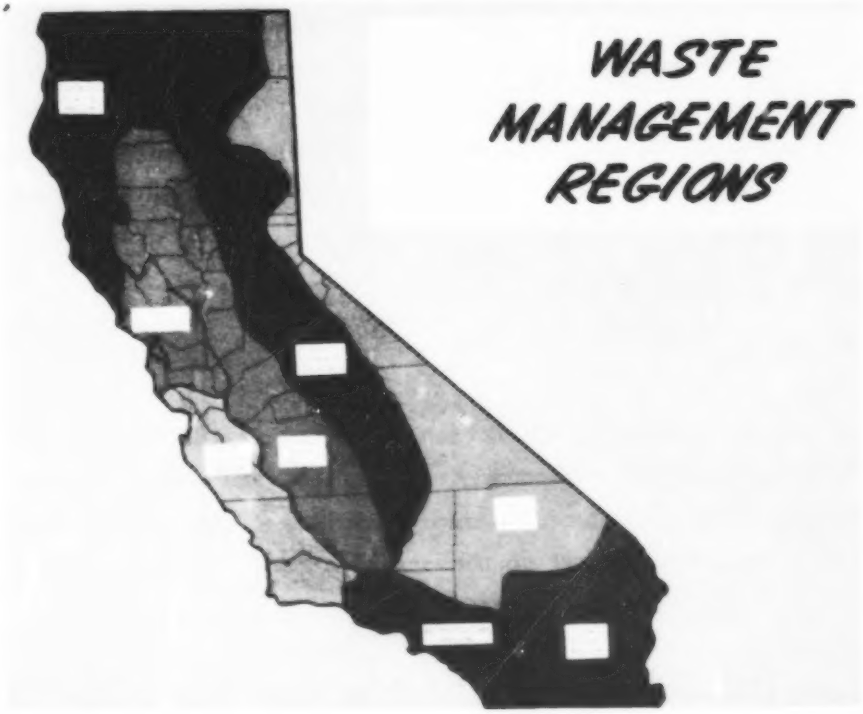

WOODLAND
SACRAMENTO RIVER
FOLSOM
AMERICAN RIVER
DAVIS
.5
SACRAMENTO
1.0
2.0
1.5
COSUMNES RIVER
COURTLAND
GALT

Figure 10


WASTE
MANAGEMENT
REGIONS

The other elements, waste input and processing functions, can be represented by analytic models and simulated on digital computers. Models have been formulated for certain aspects of solid-waste-handling systems, although we did not find any application on a large-scale basis. In exploration of the problem on a very small scale (the Sacramento area), no hindrances were found to the formulation and use of such models.

California Study Regions

Returning to Phase I of the systems approach chart (Fig. 3), there is a need indicated for information dealing with waste loading, processing equipment, costs, and political, economic, and legal constraints. For these data to be meaningful, it is necessary to consider them in the context of a particular location or area.

It was convenient for the purposes of the study to divide the state into regions in assessing the problem of water and air pollution. Generally, the geographical extent of these regions was selected to correspond to boundaries of natural drainage basins and the commonality of waste management problems. These geographical boundaries do not correspond to solid-waste-system boundaries or political jurisdictions; neither do they represent areas that may be subsequently defined by optimizing a waste management system.

As shown in Fig. 10, the state was divided into seven regions, one region having two principal subdivisions. By designating the regions we were able to consider the special problems within each in terms of waste loading, waste composition, and the natural assimilative and man-made means available for waste processing. It provided a vehicle by which we could consult authorities on special economic, political, or technical problems in their particular area.

Economic Assessment

For any region, economic information is needed to make decisions on solutions which satisfy the environment objectives. In many instances, the impact caused by discarded wastes is such that many of the resulting damages and attendant costs are external to the organization discharging the waste.

Figure 11

ANNUAL SYSTEM AND SOCIAL COSTS - REGION 2

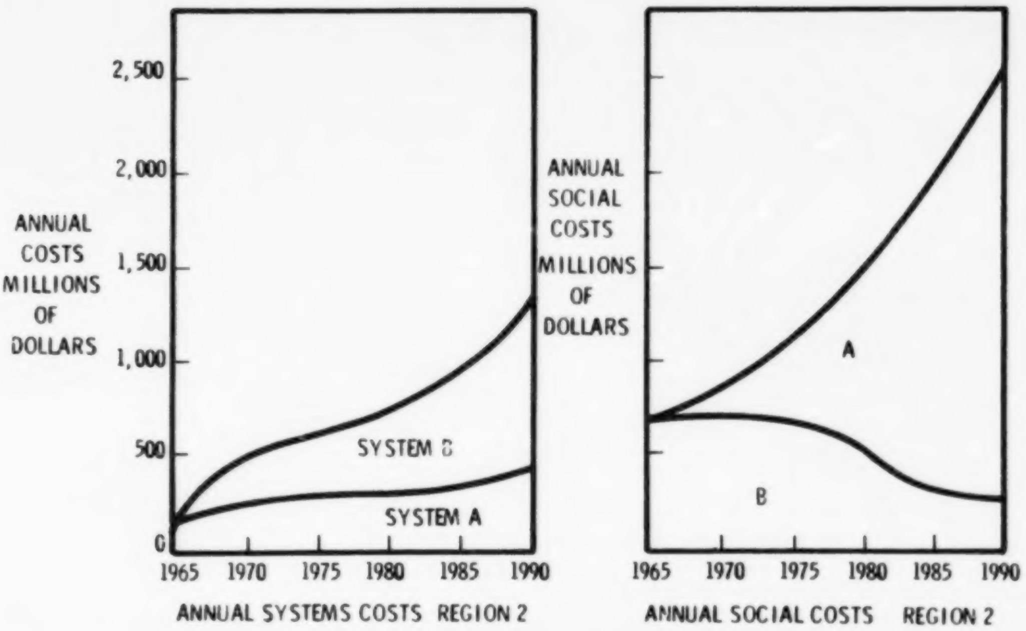
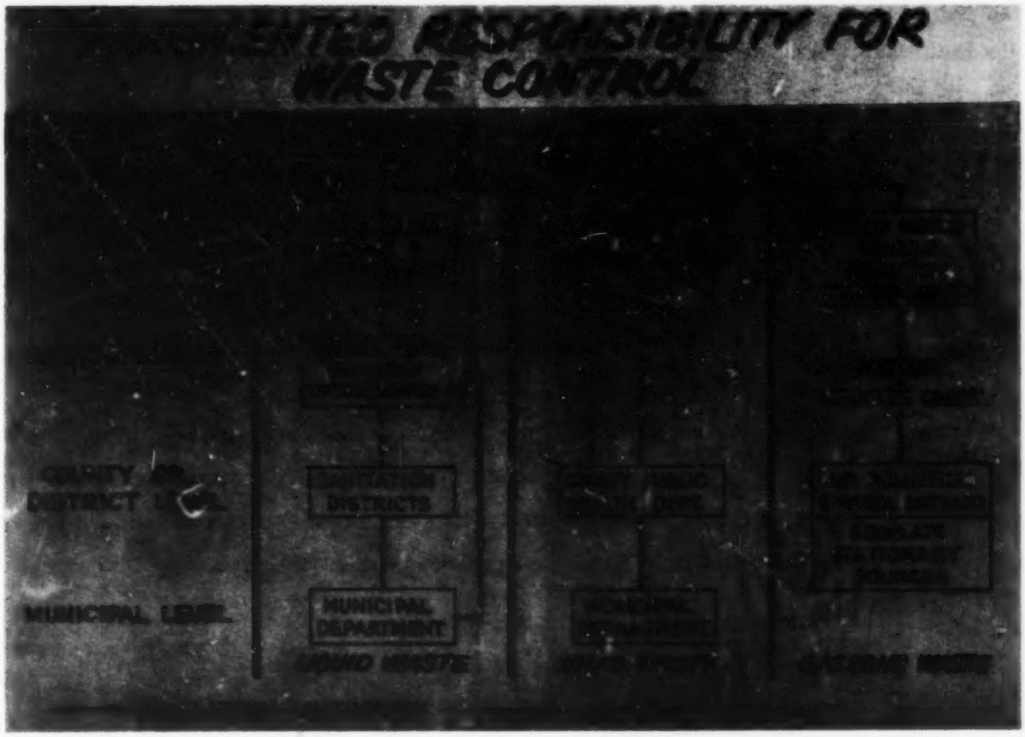


Figure 12


NTED RESPONSIBILITY FOR
WASTE CONTROL
COUNTY OR
DISTRICT LEVEL
MUNICIPAL LEVEL
SANITATION
DISTRICTS
MUNICIPAL
DEPARTMENT
LIQUID WASTE
STATIONARY
SOURCES
GASEOUS WASTE

Thus, important divergences can arise between the direct cost in terms of plants and equipment, and the social cost, and these social costs may not always be considered by the waste management organization.

A first approximation of costs, both direct and indirect, was made in the study by conceiving of engineering solutions for the liquid, solid, and gaseous pollution problems in the San Francisco and Central Valley Region. Having described the physical arrangements based upon current practices, it was possible to estimate the direct cost for equipment and facilities.

The activity of describing and costing engineering solutions is a part of Phase II. This would normally be expected to require years to complete. Consequently, our projections are extremely gross estimates of costs that may be incurred, since we were able to devote only a few weeks to this activity.

These cost projections were made on the basis of two general situations. The first situation assumed that the effectiveness of all waste processing equipment would remain at the current level, and only the total capacity would be increased to process increased waste rates. Under these conditions, the resulting environment would probably continue to degrade as compared with today's conditions.

The second situation was based upon an assumed improvement of performance of all waste handling and waste prevention practices but no improvement in the processing state-of-the-art. It was assumed that all sewage treatment in the region of interest would be at least equivalent to secondary treatment, and that agricultural drainage in this region would be piped directly to the ocean rather than being discharged into the Delta. All solid waste was assumed to be handled by sanitary landfills, and it was assumed that all gaseous waste would be improved to the point of eliminating unburned hydrocarbons from stationary and mobile exhausts. Sewage-plant costs were based on integrated facilities, where it seemed reasonable to do so instead of separate small-capacity facilities. Direct costs and social cost comparisons for these two situations are shown in Fig. 11 as System A, The Degraded Environment, and System B, which provides improved environment.

Social costs were estimated for both situations by identifying particular activities that were known to sustain economic losses due to polluted water or air. These estimated social costs are indicative of the potential economic benefits that may be obtainable with an improved environment.

From this economic consideration, we concluded that continuation of the present methods would be the more costly of the two situations.

Planning Factors

Referring again to the waste-management-systems approach (Fig. 3), it is necessary to consider planning factors such as management of a system, legislative requirements, and financial considerations. Through the regional designation, and by the use of some very obvious arrangements such as a master drain to the ocean, certain functions that would have to be performed on a regional and state level were identified. For example, it was found that each time such an intra-state system is planned to cross local political boundaries, state intervention is usually required in order to resolve local differences. Further, it was found that no single authority exists at the state level to initiate necessary legislation and to bring the various political entities together in agreement on the division of administration or related finance. A simplified version of the current state organization related to waste management is shown in Fig. 12.

One of the principal inhibiting factors to the development of waste management systems stems from public indecision on policy dealing with environmental objectives. Present governmental organization at both the state and local levels tends to reflect this indecisiveness.

Selection Criteria

There are other items of information called for in Phase III of the systems approach to waste management (Fig. 3) that need to be assessed in Phases I and II and are ultimately completed in Phase III. One of the principal items is listed as "selection criteria," which is a necessary tool to be used in the selection of a plan for a particular region. While this kind of information is completed in Phase III, parts of it are used in both preceding phases. These criteria were not considered *per se* in the California study, although they are recognized as having an important relation to successful completion of any actual project.

This concludes the discussion of the systems approach applied to waste management. Let us now turn to the conclusions of the study.

Conclusions

Some of the major conclusions of the study are (Fig. 13):

1) The quantities of waste expected to be generated in the future are such that if present procedures are continued, a continuing degradation of the environment is likely to result.
2) There are three principal hindrances to the conduct of a comprehensive systems analysis of waste management. These are:
    a) Inadequate environmental objectives which define the output requirements of a system.
    b) Lack of adequate data pertinent to effects and causing pollutants.
    c) Lack of generalized analytic models of the three basic elements of the waste management system: the input functions, processing functions, and the environment assimilative functions.
3) The problem of waste management is one that demands consideration of many alternatives, all of which can be examined and assessed by the systems approach.
4) Fragmented functions dealing with waste management policies at both the local and state levels inhibit the development of waste management systems.

Recommendations

The list of recommendations in the final report can be condensed to three (Fig. 14). No relative importance is intended by their order of presentation, but the order does, to an extent, indicate a logical sequence of accomplishment. For example, a higher degree of success can be achieved in establishing environmental objectives if the work is coordinated by a single responsible agency. Similarly, the existence of a state coordinator would be advantageous during application of the systems approach to any specific problem.

Now, what do we see as activities of the state coordinator whose over-all duty is to coordinate waste management activities that occur at the state level? Ultimately, the kinds of activities this office should be responsible for are:

Figure [illegible]

MAJOR CONCLUSIONS

ENVIRONMENTAL DEGRADATION WILL CONTINUE

SYSTEMS ANALYSIS HINDERED BY:

- INADEQUATE ENVIRONMENTAL OBJECTIVES
- LACK OF PERTINENT DATA
- LACK OF GENERALIZED ANALYTIC MODELS

SYSTEMS APPROACH IS APPLICABLE

Figure 14

RECOMMENDATIONS

APPOINTMENT OF A WASTE MANAGEMENT COORDINATOR

ESTABLISHMENT OF ENVIRONMENTAL OBJECTIVES

APPLICATION OF THE SYSTEMS APPROACH TO A SPECIFIC PROBLEM

1) The establishment of environmental objectives in conjunction with follow-on activity representatives, and maintenance of environmental objectives.
2) The identification of needed research and development programs and implementation and coordination of their performance.
3) The identification of pollution problems throughout the state, both present and future.
4) The formulation of long-range plans relative to waste management requirements.
5) The initiation of waste management programs as required to meet established environmental objectives.

Turning our attention to environmental objectives, it is recommended that the state establish air, land, and water quality objectives. These should be established as target values with the understanding that, as new information is obtained, specific values can be changed.

Existing data relating effects to causal pollutants is sufficient to start the formation of these target objectives. Through this procedure, hindrances to completion of the objectives will be identified, thus providing direction to research efforts in obtaining the needed data.

These objectives should be written in the form of a specification that:

1) Identifies the effects that are sustained by activities that come in contact with the environment.
2) Specifies the magnitude and frequency at which these effects can be sustained by the affected activities.
3) Identifies the corresponding pollutants and the relation of the effects to these pollutants.
4) Specifies the magnitude of the pollutant to be tolerated in the environment.
5) Establishes performance failure rates that can be tolerated in operation of a waste management system.

These data on pollutants, their magnitude, and allowable frequency of occurrence would form the basis of a waste-management-system-performance envelope. It would provide the designer of waste management systems with a technical definition of required system performance.

The formulation of environmental objectives is a dynamic and continuing process in that all of the objectives are subject to change with time due to new information on effects, new pollutants, and new activities that may be affected by environmental pollution. Participation will be required by state agencies such as Fish and Game, the State Planning Office, Public Health, Water Resources, Agriculture, the State Waste Management Coordinator, and other agencies representing specific follow-on activities.

A Specific Application

Finally, it is recommended that the state undertake a waste management program for a specific area, based on the systems approach (Fig. 3). The initial phase of this program should be designed to produce a plan for an operating system, including complete cost and schedule information. This initial phase should be utilized to provide documented procedures and generalized analytic tools which can be applied to other waste management problem areas throughout the country.

In summary, the systems approach to waste management as visualized here is not a plan for replacing existing systems or techniques. Rather, it is an approach to understanding the interrelations that exist among these systems and techniques so that they might work more effectively.

It is believed that, at most, the study only began the work of utilizing the systems approach in what amounts to an extremely complex socio-economic problem. We are confident that this approach will produce the means of disposing of waste economically and enhancing the beauty of California.

Acknowledgement

The material presented is based on the California Waste Management Study and on constructive suggestions by Dr. B. D. Culver, Mr. H. A. King, Mr. T. E. Walsh, and Dr. E. R. Roberts.

DISCUSSION--Application of the Approach

LESTER HAUG: In Chapter 4 on page 7 of the California Waste Management Study by Aerojet there is a diagram entitled "Existing Waste Handling Systems," showing that all solid wastes at present result in water and air pollution. I am sure that this will come as a shock to some of us who are in the business. Also, on page 22 of Chapter 6 is a chart called "Advanced Methods Waste Management System," which shows an integrated and automated system in which disposal results in land development and beautification without pollution.

Actually, the processes I think that we are going to be using, whether we have an automated waste management system or the present one, are going to be pretty much the same, though the end results in your report are different. The question, I think, is what process of logic allows this conclusion? And at the same time I'd like to point out a couple things that happen (some inferences that can be drawn). One is about the present regulatory agencies which have the problem of seeing that our water and our land are not polluted, some of these being state agencies: Could it be inferred from such diagrams that these agencies are not doing their job?

T. P. JACKSON: As to the diagram that you say indicates that all solid waste ends up in water or land pollution, I think you are interpreting it out of context in a sense. We were trying to show what generally could happen. The diagram doesn't read that it always happens or that there are no exceptions. At least, it certainly didn't intend to say that this is the case, because I know of many many cases in California where the opposite is true. Golf courses are being made and many things are done with solid waste to improve the environment rather than harm it.

I am not pretending to be a specialist in waste management at all. I'm only trying to suggest an approach that may be useful in helping create the better world which Dr. Logan spoke of. I hope you give me a little liberty in saying things that, carried to the limit, might not be true. I don't intend to present a black and white case, because, in my experience, waste and its problems are not black and white. It is all gray; this is one of the problems.

LESTER HAUG: The graph in Chapter 6 entitled "Advanced Waste Management Systems" now shows that disposal results in land development and beautification without pollution. I believe that these charts, when you compare them, may lead to various conclusions, one of which is that, once we get an automated waste management system, we will have all these side facets accruing and that we won't have it without a waste management system.

T. P. JACKSON: The object was to point out that when one has environmental objectives one will probably obtain the answers wanted, but that will happen only accidentally otherwise. An automatic system was our idea of what may happen in the future, but we also put down the idea of golf courses, etc., as you saw. I could also point out in the figure you mentioned previously that some systems provide these benefits today.

LESTER HAUG: Throughout the report the present system is generally characterized as a high-pollution system. In Los Angeles County there are no real water or land pollution problems stemming from disposal of either solid or liquid wastes. However, there is an air pollution problem, and the air pollution control district, the county district, has done a commendable job of reducing pollution from industry. The main problem, what to do with the harmful effects from engine exhaust, is under the jurisdiction of the state; yet, as far as the report is concerned and the recommendations that would be made, you would remove the liquid and solid wastes from local jurisdiction, placing them under a state agency when the state is in the position of having been unable at present to solve the problem of what to do with an agent of smog which is under its jurisdiction, namely the automobile. The question is, how are you going to sell this politically to the State of California when the state is in the position that it is?

T. P. JACKSON: In the first place, we have listed in the report certain functions that we thought had to be carried out on a state level. I know that it's a touchy subject when I mention the word regional, but we must settle on an area that encompasses the environmental-control problem we are dealing with. We've only listed those functions. For instance, one of the functions that we listed was work on determining environmental quality or standards or objectives. You know this is being done in air pollution at the state level. This activity does not, in a sense, take anything away from the local governments at all, does it? It's the county pollution control district that sets everything on stationary exhausts. The state function establishes the standard for that particular environment. Now there are other environments also. Maybe it's not necessary to have one for the whole state, in the case of land. I'm pretty sure it isn't. In the case of water, we already have regional water control boards, which, of course, are at the state level already. I think, here, that the report really lists functions of things that we think have to be done if you're going to do anything on a big scale. It doesn't say that all of these things have to be done at the state level, and it certainly doesn't lay out the kind of organization, local or statewide, that would have to be formed; we didn't know, we still don't know, about that, because, remember, one of the things that I pointed out earlier is that, in a systems approach, you identify the functions that have to be performed, and that's where we left it. We never came up with the system that would put these functions into operation. You can apply this to the state political system as well as to the mechanical-waste-management system. Well, I'm not trying to sell the idea that the state should take over all local functions. What I'm saying is: here are some of the functions that must be performed if we are to move anywhere in the next 20 years. Also, I'm not saying that we're not moving now; rather, here's an approach that really works if you gentlemen wish to use it. It gives us a framework and it gives us a pattern of logic in which we can make decisions. That's all it does. It doesn't make any decisions; the approach provides the information needed for decisions based on logic.

SAMUEL E. WOOD: We all know that Los Angeles is an unpolluted area. We know that they've saved the essence of their environmental beauty down there. We know that the place doesn't stink. We know that they're doing a wonderful job with all their waste disposal, but I would like to suggest to the gentleman from Los Angeles (Lester Haug) that there are other parts of California that need help. Los Angeles County is probably solving its problem, but it is not solving problems of the other counties south of the Tehachapi--which ought to be involved in a unified, integrated, regional waste disposal situation, including the whole problem--air pollution too. But there are areas in critical need of regional organization and integration. For example, the San Joaquin Valley is one vast sewer, with stuff being dumped from small inefficient systems into the San Joaquin River, into the Sacramento River, to such a point that the whole area is becoming polluted. Some areas are just now getting on sewers. The same thing is true of air pollution as is true of water pollution. I would suggest--and the Bay Area, for instance, needs one grand collector--the whole thing be integrated into the San Joaquin Valley drain and the Sacramento Valley drain, handled on a regional basis larger than any of the regions we have now. So I think that the regional approach on this is vital, but I'm sure it won't happen without very strong state intervention.

BOB SPRADLIN: With regard to some of your major conclusions, one of them was that there was a lack of generalized analytic models to describe the solid waste management system. I wonder, at the outset of the study, was it your hypothesis that there would possibly be a generalized analytical model to describe a system that complex?

T. P. JACKSON: No, I suspected that nothing like that existed. I had to look for it first, though, before I could decide or say honestly that it doesn't exist. Analytic models are essential, and it was necessary to answer the question "Can such complicated models be made?" The models give us a way to manipulate parameters and find out what happens on paper. We're not bound and tied to the real physical system, and this is what one needs.

BOB SPRADLIN: With regard to one other major conclusion, lack of pertinent data: are you implying there that there are no people associated with the management of solid-wastes systems who can describe cause-and-effect relationships with regard to the variables of the system well enough to formulate some sort of descriptive model?

T. P. JACKSON: I said there is a lack of data, implying both statistical and descriptive data; there's a lack of information, but it's not completely absent. There is some information available.

WES GILBERTSON: I think, Mr. Jackson, you did a good job in defending yourself in a situation where you admit you don't know much about it, and I think you did a good job in bringing out the kind of an approach here which is useful. You also avoided getting yourself trapped into a situation of trying to get too specific where, obviously, you had some difficulty in the length of time and the depth that you could get into here--or that you couldn't get into, you might say. For this reason I want to say that I think the more specific delineation of this approach has been quite useful for the group here.

Then, I want to get on the other side and criticize one point. I think you're far too modest in this deal. I say that for a reason. You imply here, if I understand you correctly, that the systems analysis and the systems approach is limited to the waste management system with the input boundaries that you specify. Now, if there is real value here in this system, as we understood it from John Logan and from Dr. Brown, the question comes to my mind as to whether the analysis doesn't go farther back into the production of the generation area than you implied? I say this because I think that, in the solid-waste area, there are some real questions about whether, for example, the kind of packaging that we're using today isn't really or shouldn't be part of this whole analysis. Or you could go back into the question of, in the water side of the picture, some of the ways in which processes are carried out in the plants themselves, or perhaps the way which we are actually handling our waste in the homes and apartment houses. So, I think, if I got your position correctly, I think you're far too passive.

T. P. JACKSON: I agree with you that waste generation has to be considered and analyzed. There are differences, however, that I'd like to point out. The waste manager's responsibility needs to be limited as defined by the input boundary. I also indicated that there is a need for reporting, and I should have indicated that there is a need for analysis at this interface which takes into account some of these waste-generation problems that the waste manager is confronted with but has no control over. One can analyze the world but one ought not to control it. What I was trying to say was--as far as the authority of the system was concerned, perhaps a good place is at the input boundary shown in the diagram. Control of waste-generation area involves waste prevention. If the waste manager is the waste-prevention authority, I know just how we can solve the waste management problem. So it's the authority of the waste manager that I was trying to indicate, more than the boundaries on any waste management analysis.

HERMAN JANZEN: You mentioned, or indicated in a figure, a need for environmental standards, objectives. We do have objectives; we have extreme standards for water pollution. We have air pollution standards; the offending, irritating elements have been identified and standards have been established. We have standards for minimum housing; we have standards which affect just about everything except waste disposal. So, therefore, what we in waste disposal feel a need for is help in finding out what standards people want, what is desirable. But then you run into the problem of "We know good and well we don't want our neighbor to dump his garbage out on the ground, but if I'm taking a walk through the woods and I toss out an apple core, that's the other extreme. There's no harm." But somewhere in between we have to establish some kind of standards. Who's going to do that?

T. P. JACKSON: You bring up a real problem in the area of solids because most of the solid-waste impact upon the environment has to do with vector propagation. Esthetic enjoyment is, of course, affected by solid waste. There is a need for some additional specification or standards in the area of esthetic enjoyment. I suspect the impact of solid-waste disposal on esthetic enjoyment must be significant. There are standards for water and air, but seemingly none for land.

MRS. GUPTA: Of all the experts in the audience, can anyone tell us whether any standards have been established for solid-waste disposal in your community? We have representatives from practically the whole country here. Is there a total absence of such standards?

BEN LINSKY: I think you'll find that there are some esthetic standards, some operating standards, for solid-waste disposal in the quality of the way wastes come out of types of municipal incinerators built under contract and guaranties. Also, there are some standards for fire protection and the covering and scaling of sanitary landfills. You'll also find, I believe, in some parts of the country, special land-use permits. Some particular specifications for screening of one kind or another, sometimes by specific design fencing, both see-through fencing and non-see-through fencing as well as vegetation and trees.

I want to clarify the statement that we have standards for air quality. Actually, we don't. The very few standards which are called standards for air quality which have been adopted exist in California, and they are standards that guarantee dirty air. They are not clean-air standards, and they're only for a very few materials. These are not standards for clean air. We have a visibility standard, the particular standard is a visibility of three miles, which is unacceptable in any other community in the United States.

DWIGHT CULVER: This lack of cause-and-effect relationship, whether it be litter on the ground, obscuring visibility in the atmosphere, or transmission of disease in the water, this almost complete lack of cause-and-effect relationship makes it extremely difficult for you gentlemen to establish standards that are going to be meaningful to people who are going to design the systems of the future.

T. F. JACKSON: In order to make things meaningful in a specification, you have to start with an effect: what it is that's causing the problem to somebody or something in society. Then you determine what the permissible frequency is, and later you identify the factors in the environment that cause the effect. At this point, one may relate the maximum concentration of factors in the environment. You'll notice, over here, we list the effects on people and other life forms. It's this relation between effect and a pollutant referred to by Dr. Culver.

FRANK STEAD: I think we need to make a distinction between a highly localized problem of concern only to one small piece of property or one small jurisdiction, and the growth of that problem, the spilling over until it begins to affect a resource which is the common property of many people, many communities, etc. Now, the clearest illustration of the need for the systems approach to deal with a resource problem has been pointed out here with respect to air. If you have a factory and are carrying on a process and the air inside of that room becomes polluted or contaminated, that's a localized problem and you have standards. But the group in this room becomes concerned with an air problem when it escapes from the control of the person generating it and begins to affect the total resource. With respect to air, anything happening outdoors is immediately visible, so that I don't think anyone has any problem with the concepts of the Aerojet report when you reac it. And I assure you that this is a come-on to get you to read it; these discussions are on the air system. It's relatively simple to handle this concept with respect to water resource. The so-called assimilative capacity of the water resource is soon reached with respect to organic loading, and it's reached immediately with respect to mineral loadings. There is no equilibrium value with respect to mineral loadings unless you are carting out the same amount that you cart into a basin. But I think our real problem is on the subject of this conference itself: how does this fit the solid waste resource? And the comments from Los Angeles County, I think, sharpen this up. Sure, there are standards for highly localized management of wastes on a piece of property. These standards are public-health standards, nuisance standards, etc. But I think the beginning point of the solid-waste discussion with respect to what it does to the land resource is when the assimilative capacity of the few holes in the ground that we have left is gone. Then you go above-grade. Then you begin to pollute the land resource, and that day, whether it's 10 years off or 30 years off, is the day you want to begin thinking about now.

MRS. GAWAIN: I've been very interested for several months in Mr. Jackson's report, and particularly pleased by the emphasis on a need for some environmental objectives. We think that we need these environmental objectives for a number of other purposes besides waste management. And we think that the same procedure could certainly be used for establishing a level of tolerance of destruction of the environment with regard to other purposes, like transport, housing, and many other things. Would you agree with that?

T. P. JACKSON: Yes, I certainly agree.

MRS. GAWAIN: I think that, probably, our greatest problem is that we have no social or political institutions for establishing such standards or objectives. Perhaps our state office of planning and the California State Development Planning Program might be able to help establish a procedure or an institution for evolving such objectives and standards.

AL BALDEN: In reference to the standards on solid waste, the state of Michigan last year passed a law which gave the Public Health Department the right to regulate the licensing of dumps. To implement this law, they have written 2 pages of criteria on what is permissible and what is not permissible in the use of such public dumps. This might be a step in a direction that you are interested in.

WM. HARRINGTON: One thing I've noticed throughout this meeting is that people have used the word "dump." If you don't worry about that, you're not going to improve. Refer to them as sanitary landfills, and make them be operated as sanitary landfills.

I'd like to take exception to Mr. Gilbertson's idea of the control of refuse at the point of generation. I was quite pleased to see that you are following what we have normally considered as the engineering aspect of this thing: that we take the refuse we get and try to dispose of it by a method which will not destroy our environment but without trying to regulate our society. We have these wastes as a product of our society as we know it and enjoy it. I think our job is to begin at that point and do something with it. Now, I know this goes beyond the scope of your report because you're giving us a way of approaching the problem. However, I don't think there's anyone in this room who knows enough about the solid waste itself at the beginning, at the point of origin, to be able to do much more with it than we are doing now until some pretty definite research is done to establish the actual characteristics of this material that we have to dispose of.

T. P. JACKSON: I think that we are in agreement that the input boundary occurs at the point at which material is discarded. You're also telling us that it's going to be very difficult to develop a real meaningful, or at least a complete and sophisticated, model of the input function without some research to determine solid-waste composition. Frank Bowerman informed me of this on the way over here yesterday. He indicated that it is difficult to get information that is really truthful in regard to the composition, quantity, and distribution of the waste.

THERE HAS TO BE A PONY SOMEPLACE

J. L. McDonald

Arizona Public Service Company
Phoenix, Arizona

Mr. McDonald was Master of Ceremonies at the evening dinner. His introductory remarks were so germane that they are incorporated as a part of these proceedings.

Mr. McDonald is in the Public Relations Department of the Arizona Public Service Company, the gas and electric utility company for Phoenix. His speech explains his interest and involvement in the solid-wastes problem.

Certainly I have pride in the fact that I am on the speech committee for Keep America Beautiful, Inc.--and this has taken me into a lot of wastes and the waste lands of America.

We have listened to many people talk about billboards and junked automobiles--even Mrs. Lyndon B. Johnson herself, and she has a terrible aversion to these particular items. But there is more than just billboards and junked automobiles, and we have talked about these: the disposition of wastes, what to do with wastes, and "how not to be inundated by wastes."

We have worked with a lot of optimism in this field because we are, after all, a rather wealthy country--with alerted education, politics, technology, and I don't know what, simply because we are American--United States of America Americans.

New industries have been discouraged, schools haven't been built, progress has often been stopped because of wastes. News stories have told us of the dire things that are going to happen to us, water-wise, sewer-wise, garbage-wise. Is there no ray of hope? Are Americans not capable of lessening the problem with know-how and certain optimism?

Do you remember the story of the father who had two sons--one an optimist and the other a pessimist? The optimistic son believed in everything; the second boy believed in nothing.

Not pleased with either son, the father, on Christmas Day, performed an act that had his pessimistic son receiving every gift imaginable from Santa Claus. And when this boy came downstairs, it was with complete pessimism that he told his dad that jolly old Santa had made a mistake: he had left this boy too many toys. All of the things in his room just couldn't be his.

Now the father during the night had filled the optimistic boy's room with those wastes we call fertilizer, and he knew when the boy failed to make an appearance that he must be lying in his room heartbroken and despairing. But on entering the room he found the little boy was whistling and working like mad.

"Santa wasn't very good to you, son," the father said.

"Oh, I don't know about that, daddy," exclaimed the little fellow, who was shoveling the foul stuff out the window. "With so much of this around here, there's got to be a pony someplace."

And I think that is what we have learned at this conference. It's up to us to come from this meeting with a high degree of optimism that will reveal the pony as well as the wastes.

Those of you who have youngsters who are still children--children who meet you at airports and say, "What did you bring me, daddy?"--know that children are sometimes pleased with just a pencil, a table decoration--just something that you have brought them from some place you have been. Think of them.

Certainly you will not be taking solid wastes or liquid wastes back to anybody--but sometimes you do take just that back from conferences where no resolves have been made to at least try to get through the research and findings programs that are being indulged in across the country.

If our troubles in this field are great, we should not lack faith and optimism in meeting our problems head-on.

We might tell that child who believes in us: "I bring you a word of hope that people are growing up, that people are trying to find ways and means to get over the garbage dump; to do something about the junked everything that dot our lives. We are going to stop worrying about air pollution and do something about it."

It's only when you are doing something for someone who is terribly young that you get inspired. One-half of our population will be 26 years of age or younger by the year 1970. That will be a very young world.

This is a world of possibilities. And that might be a good gift for the child who is moving toward that world. His concern about wastes is your concern today. And when the child asks where this or that went, don't take examples from far-away places like Bangkok or Mexico or Europe.

Marvelous old Italy, with its wonderful cathedrals, has still not learned the proper disposal of wastes--but in this country at least--America the Beautiful--we do have a fair chance to get rid of the problems that have plagued man as he has learned to develop the paper carton, Kleenex, the numerous things that are so easy to toss away and so fearfully hard to get rid of.

The Washington Monument is a good use of aluminum; the beer can is not. Aluminum doesn't rust like the tin can. But engineers, instead of giving up beer because it has been put in aluminum, will continue to drink the beer--and find a way to use or reuse the waste product.

Child-like, not childishly, we should adjust some of our thinking to be filled with solid optimism about our future. We should be sure our stories and our needs are being heard. We have to get down from our ladders--get down and wallow in the story we are trying to tell.

Don't forget the ladies. A woman's club can bring about major changes in a community, a state, a nation, a world, because women listen and act. I've had some success with this group with one idea--garbage cans. We have found that decorated garbage cans fare better than poorly kept ones. The ladies wouldn't use the motto I designed--"Why not have the best-dressed can in town?"--but they did the work!

Garbage cans bedecked with roses, fine arts, you name it, they did it--and their motto? "Why have a garbage can that's messed up when you can have a garbage can that's dressed up?"

What are we talking about when we talk about wastes? Pollution of air? Bad water? Sewage? We are really talking about this country's future. What lies ahead if we remain as researchers, as engineers, very learned people who know how awful everything is--but never quite get over studying' and doing nothing about it.

Sometimes we are guilty of belittling mankind, often forgetting we are mankind. We speak of man as an animal, which he is not. We make a chemical goo out of him--and set his value at $1.67.

Our job is to lift mankind a little higher than it was when we arrived on the scene. We must work with clubs, professional societies, private industry, municipal organizations, and youth.

We can take mechanical intelligence and let the computers tell us what is wrong about the tonnage or whether there is any air space in the concrete--we won't want to build on top of it. Let our work show like the green grass--don't always be looking for the grassroots. Always be sure the telescope is seen from the right end. Looking in the big end, you get only a small view.

I'd leave you with one thought: Don't project everything into the future. Do something so that you can enjoy the pony.

Go back home with optimism. Love mankind enough. It's hard for scientific people to lift mankind from the solid wastes and every other kind of waste man has created.

But he is there. Work for him, and you'll have found something for yourself.

That's my two-bits worth for the evening.

MANAGING SOLID WASTES FOR A BETTER ENVIRONMENT

W. E. Gilbertson

Chief
Office of Solid Wastes
U. S. Public Health Service
Washington D. C.

Mr. Gilbertson heads up the federal office most directly concerned with solid-waste management technology. This position was created when the 1965 Congress passed the solid-waste bill. Previously Mr. Gilbertson was Chief of the Division of Environmental Engineering and Food Protection, U. S. Public Health Service. He is a registered engineer, and a commissioned officer in the U. S. Public Health Service.

I believe we have arrived at a turning point in the centuries-old struggle to figure out what to do with solid wastes. I think, frankly, that we are now, for the first time in history, on the road toward resolution of the solid-waste problem, that the opportunities for dramatic progress are greater today than ever before. I say this in full awareness that the burden of solid wastes is going to spiral upward during the next two decades, and that this country, by and large, is ill-prepared to deal with this problem in its present dimensions, to say nothing of what the future will surely bring.

But I submit that the seeds of victory are already planted and taking root. They need nourishment, and room in which to grow. But, given the best cultivation we can provide, the seeds of victory will yield a harvest that will enrich this land beyond our fondest dreams.

The whole subject of solid-wastes management is coming under a kind of scrutiny that it has never had before. People from many different walks of life are taking a hard look at the solid-wastes problem, people who in the past had little reason to give a second thought to solid wastes, and whose first thought usually was a vague notion that the trash was being picked up and taken away somewhere--and good riddance. But now we find legislators from the nation's capital to the town council thinking about, and even worrying about, solid-wastes disposal. We find distinguished groups of engineers and scientists exploring the problem and methods of dealing with it in exhaustive detail. As you may know, a comprehensive report, entitled "Waste Management and Control," has just been published by the Committee on Pollution of the National Academy of Sciences--National Research Council. We find citizens and voluntary organizations like the General Federation of Women's Clubs seeking information on what they can do to foster better solid-wastes management. We find, in short, a rising level of concern for this problem and a growing desire to figure out and do what can be done to bring it under control.

All of us surely welcome the new prominence, or notoriety, that the solid-wastes problem is getting, especially those who have been struggling for years to win some measure of recognition for a problem which everyone else seemed only to want to ignore. But what to me is equally as important as the new attention being paid to the subject of solid wastes is the new light in which it is being viewed.

What might be called the traditional view of solid-wastes disposal--something akin to "out of sight, out of mind"--is giving way to a concept of solid-wastes management as an integral part of environmental quality control. As surely as we are living in the atomic age, or the space age, we are living in the age when man first began to question what he was doing to himself by failing to reckon with what he was doing to his environment. And no one--neither scientist nor public administrator nor enlightened citizen--can long fail to recognize that our present ways of dealing with the problem of solid-waste disposal are among the most serious and potentially dangerous insults to the environment of man, and thus to man himself.

One of the seeds of victory, then, as I see it, is the fact that the American people today will no longer tolerate a steady decline in the quality of the environment. I use the word "tolerate" advisedly, because I think generations of Americans--well-meaning, thoughtful people--have in fact tolerated environmental contamination literally from the earliest days of colonialism. The necessary, but nonetheless ruthless, opening up of the land involved the destruction of millions of acres of timber. The discovery of vast mineral deposits led to mining operations which further marred the face of the North American continent. Our forebears set about to exploit the land with little or no regard for, or even awareness of, the effects of what they were doing on the environment.

As urbanization and industrialization began to leave their mark on the world in which we live, some visionaries put forth the idea that environmental conditions in mill villages, mining towns, and industrial cities might have some adverse effect on health and welfare. But such ideas, to the extent that they cast doubt on the virtues of industrialization and urbanization, were no deterrent to the running tide.

Today, that tolerant attitude is gone. In its place we find mounting concern for pollution of air and water, and of the land itself. We find scientists and lawmakers, conservationists and public health authorities, journalists and civic leaders raising serious questions about the quality of the environment and the hazards of health and welfare that are closely tied to the state of man's physical surroundings. The prevailing attitude, as I judge it, now is: We want industrial and technological progress; we want the advantages that urban living offers; but we will not accept these things in a world so beset by environmental pollution as to make a mockery of our progress.

The factors that have made this change in attitude possible are too numerous and complex to be explored in this talk. Certainly the sheer growth of pollution problems, especially within the last several decades, is one factor. Increasing scientific understanding of the health effects of pollution and of its economic impact is another factor. And perhaps the most important factor of all is the passing into the public consciousness of knowledge that not long ago was the exclusive property of the scientific community. The American people now understand that there is a relationship between the exhaust fumes from 60,000,000 motor vehicles and a threat to their health and well being. They know that the combination of pollution and increasing demand means that every gallon of water that flows along the nation's waterways has to be used at least twice before it reaches the sea. And they know that indiscriminate disposal of solid wastes can cause a triple health threat--through air, water, and soil.

The people of the United States have become conscious of the environment as their ancestors never were. They are alert to environmental pollution, whether it be the visible orange plume from a steel mill or the invisible trace of pesticide on an apple. To be sure, they want the steel and the products of steel, and they want the apple. But they don't want--they will no longer tolerate--the environmental contamination that was once innocently accepted. Moreover, the people of this country are increasingly demonstrating a willingness to make the necessary investment to achieve and maintain a better, cleaner environment.

It is obvious to us attending this conference that the generation and disposal of solid wastes are intimately connected with problems of environmental quality control. I believe that it will be just as obvious before long to the people of this country, not just those who live across the street from an open dump or next door to a smoking incinerator, but to people who have had no concrete reason to think of solid-waste management as a problem which vitally affects their health and welfare. A prime example of the translation of public concern into public action is the recent action of the State of California in imposing strict curbs on the filling of San Francisco Bay. We will undoubtedly see many more such examples in the months and years ahead.

We hear it said that there is widespread apathy about the problem of solid wastes, but in my view this apathy is, or soon will be, giving way to enlightened concern. Part of the problem, part of the reason we do face apathy about the problem of solid wastes, results from the insidious success that solid-wastes disposal has had in the past. When the burden of municipal, industrial, and agricultural wastes was small, when urban centers were not experiencing the exponential growth that is commonplace today, traditional methods for getting ride of wastes were satisfactory, if not very desirable. The dump on the outskirts of town bothered few people, and most of the community was entirely satisfied to have its wastes hauled out to the dump and forgotten. The smoking incinerator was almost always in a rundown part of town, and the people who had to endure the daily dose of dust and fumes were in no position to bring about a change for the better.

But now the outskirts of town are either part of a fashionable suburbia or highly prized commercial development land, where swarms of pesky flies and rats are no longer tolerable. The edge of suburbia for one city often merges with the edge of suburbia for another, and the places to dump or burn solid wastes are, as you well know, increasingly hard to find. This fact, coupled with the new national attitude toward protecting and restoring the quality of the environment, means that the old ways will no longer serve. We have to find new ones. We have to meet the challenge of solid waste management with innovation, imagination--with creative genius, if you will.

I spoke a few moments ago of seeds of victory, and I said that the new national awareness of the environment as a vital factor in determining the quality of human life is one of the seeds of victory. Another is the new kinds of skill that we can now bring to bear on this problem.

The enormous complexity which advanced industrial technology and expanding urbanization have imposed on the generation and disposal of solid wastes means that the old, antiquated approaches to ridding ourselves of wastes will no longer suffice. We can still afford a trial-and-error approach, but we cannot commit our errors in the community, and we don't have to. Through the tremendous opportunities which computer technology and management engineering afford, we can plan, try, correct, and try again totally new approaches to meeting the challenge of solid-wastes management. We can factor into our planning not only economic considerations and mathematical models of disposal systems, but also meteorology, trends in packing and marketing, and many other considerations which have never formed the bases for the development of solid-wastes disposal plans.

Furthermore, we can draw on scientific and engineering resources that did not even exist a decade ago. The aerospace industry will, I am sure, have much to contribute to the field of solid-wastes management. This conference itself is strongly related to the State of California's contracts in connection with planning for solid-wastes management in California. I feel sure that other organizations from other sectors of industry will find it possible to apply their skills and talents to the solid-wastes problem. We need them, and we will welcome them.

I think what I have said so far implies that one of the needs that must now be satisfied in the area of solid-wastes management is coordination, a means of drawing on and effectively using both the rising national demand for better environmental quality control and the new kinds of technical and management resource that are available to develop better means of meeting the solid-wastes challenge. That need, too, is being met by the expanding role of government, particularly the federal government, in the area of solid-wastes management.

The adoption of the Federal Solid Waste Disposal Act of 1965 will do much toward coordinating a national attack on the problem of solid wastes. It will speed and expand research and development, it will provide a means of carrying out studies, investigations, and demonstrations of new and improved methodology, it will make possible the training of professional personnel to assume responsibility for developing and conducting solid-wastes management programs, and it will help bring together and make available basic data on the solid-wastes problem which is either scattered and diffuse or totally lacking. Improvements have been erratic and achieved by crises; now we can assist in much-needed statewide and interstate planning. All of these activities are undoubtedly essential, for, without them, progress in the field of solid-wastes management will be slow and uncertain.

In developing and adopting this legislation, the Congress enunciated a point of view about the solid-wastes problem and about how its solution ought to be pursued. That point of view is expressed in a portion of the legislation which I think we sometimes tend to overlook. It is the section called "Findings and Purpose," Section 202 of the Act. What it says constitutes both a statement of principles and a mandate to all who share responsibility for creating and solving the solid-wastes problem.

The Congress has declared it to be the policy of the United States that the primary responsibility for collection and disposal of solid wastes rests with state, regional, and local agencies. This is noteworthy in view of the fact that not one quarter of the states have taken any legislative action in connection with the solid-wastes problem, that regional agencies responsible for solid wastes are almost unheard of outside California and a couple of other states, and that half of the urban places in this country with populations of 2500 or more are not doing even a minimally acceptable job of solid-wastes collection and disposal. I think it's only fair to state that the federal government hasn't been doing its share either--whether at its own installations or in terms of assisting others. The Act goes on to state that solid-wastes collection and disposal is a national problem, and that the cities and states therefore need and should have the aid of the federal government.

The federal government, then, is charged with the responsibility of providing financial and technical assistance to the cities and states and also of providing leadership in the development, demonstration, and application of new and improved methods and processes to reduce the amount of waste and unsalvageable materials and to provide for proper and economical waste disposal practices.

It is important to recognize that the Congress has given equal emphasis to reducing the amount of wastes and to waste disposal. We cannot limit our attention merely to the task of finding better ways of getting rid of solid wastes. We must, at the same time, devote much more resources and energies to additional technical approaches, such as reduction in the amount of wastes and more extensive recovery of potentially valuable waste materials, that will have a great effect on meeting the problem of solid-wastes management.

The federal government is perhaps uniquely able to provide the leadership needed to find ways of reducing the amount of solid disposable wastes generated in this country, for this could well involve significant changes in national production and marketing practices, areas in which many agencies besides the Department of Health, Education, and Welfare have a direct interest.

I mention this to give you an indication of the point of view that the Congress has taken in developing legislation dealing with the solid-wastes problem. The Congress has called for innovation, for new thinking, for bold approaches; and it has called for new targets and goals--national goals, state goals, and local goals--all relating to a higher quality of solid-wastes management. The legislative history of the Solid Waste Disposal Act indicates that the Congress contemplates a broad program of support for application of proven advanced technology in the area of solid-wastes management, but advanced technology still awaits development and trial. The urgent task we face today is to come up with the new and improved methodology that will merit full-scale and widespread application.

When we speak of management in connection with improving solid-wastes disposal, I would like to suggest a fairly broad definition of the term. I would like to include the concept of utilizing a wide array of leverages to obtain solutions and improvements. For example:

--let us make certain that we are challenging to the utmost the expertise and competencies of industrial and other private enterprise personnel;

--let us utilize federal, state, and local public facilities as centers for demonstration and innovation;

--let us use performance specifications when we purchase, rather than the produce specifications, so that we will broaden the area of competition and encourage new designs;

--let us make regional intergovernmental cooperation really attractive.

If, as I said at the beginning, we are on the road toward solution of the national solid-wastes problem, it is also true that we have a long way to go. For the first time in history we have opportunities to draw on--opportunities in the form of growing national concern, new scientific skills, and a political framework that calls for, and will help make possible, real progress. We can treat ourselves to a feeling of cautious optimism, because some of the most formidable obstacles to progress in the solid-wastes field are being knocked down. But the scope and complexity of the problem have never been greater, nor have we ever before faced such urgency.

We have come full circle in our approach toward the problem of solid wastes. Our goal is no longer limited to finding cheap and easy ways of putting the solid-wastes burden out of sight and out of mind. Our goal instead is to build a better environment, and to do this we must manage our solid-wastes problem, even use part of it as a resource. We can do this, and in so doing we can create an environment that will many times over repay our efforts in the priceless currency of better public health and human welfare.

LEGAL FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH

J. A. Nejedly

District Attorney
Contra Costa County
California

Mr. Nejedly is an engineer's lawyer. He has participated on a great number of panels and programs, educating engineers in public government and law. In fact, he has taught engineering law at the University of California.

He has been honored by his community of Walnut Creek as man-of-the-year.

Contra Costa County has a population of half a million; Mr. Nejedly is its elected district attorney.

My responsibility today is to bring to your attention the mechanics that may be available to organizations to provide the type of area management of solid wastes that I think we all agree is not only desirable but absolutely necessary, particularly in the tremendously growing areas of California in which facilities for solid-waste management and demand for disposal are today on an obvious collision course.

In Contra Costa County, interestingly enough, we have had an alternative solution which has been arrived at by an operator and political organization combination, since in our county the garbage operators have combined to determine areas of operation and have secured for each of these areas a franchise for the conduct of the business there. They have jointly agreed upon waste disposal sites, and, because of the security incident to their franchise rights, they have had the capital capacity to develop effective planning for the future. This type of arrangement is not often found, and in most cases the emphasis and the means through which solid-waste management can be established on an area basis might be through some type of political organization.

It is my purpose to bring to your attention some of the problems incident to political organization, and, in particular, a means by which such organization can be developed. Many of the waste disposal areas that are effective--either for operating reasons or for other reasons--may extend beyond a state line. Our first consideration in this area, of course, is then the necessity of obtaining from Congress authority for any political organizations to extend interstate or intergovernmental units between states, agreements for the development of solid-waste management. There is only one such agreement in the United States today. Where the political organization does extend beyond state lines, the first consideration is this problem of obtaining prior consent of Congress.

In some states there is no authority whatsoever for interstate agreements. However, some states do provide it, particularly North Dakota, specifically spelling out the authority of the state government itself but authorizing no subsidiary political agency to enter into agreements with political agencies outside of its boundaries. Even without the state authority itself, it is presumed, because of the authority of Congress to approve agreements between the states, that the states themselves have constitutional and statutory authorities sufficient to authorize entry into agreements with other states. The second problem, aside from the interstate relationship, is the development of relationships between political agencies within one state. Utah and Rhode Island provide examples of a serious roadblock that must first be considered. In these two states, intergovernmental relationships are prohibited as a matter of constitutional limitations. The first consideration in a state having this limitation would be, of course, elimination of the prohibition itself before the political organizations within the state can develop any relationship in the area of solid-waste management. Other states, like Kentucky, Montana, and Virginia, do not have a prohibition but provide no authority. It is necessary in such states to return to the state legislature, and secure legislation on a state level that would provide and authorize intergovernmental contracts or arrangements between subsidiary political agencies. In many states (examples are Idaho, Ohio, Michigan, Oregon, Washington, and, in particular, California), the legislature has gone one step further and specifically authorized intergovernmental relationships in this area of solid-waste management. These can be established by following the examples of such states in various ways.

The first, which has been authorized in a rather loose fashion, is authority for intergovernmental agencies developed simply from factual relationships, the joint exercise of powers agreements. In these agreements no sovereignty is lost by any of the contracting parties, but they simply determine in quantity an economically feasible interrelationship and by contractual relation develop the mechanics of a solid-waste disposal program in the areas affected by the agreement. There is no limitation, of course, on the number of political agencies that can enter into such a compact, and the compact need not extend to the total area of all the governmental agencies involved. The relationship is entirely contractual; no political organization is created to control the various political agencies that are party to it, and in many cases there is an emphasis on these types of arrangements because none of the local control of any of the political agencies is affected.

The second general means through which this intergovernmental relationship can be established through statutory authority is the development of special districts, which necessarily must be created by the state legislature. In California we have a number of examples of this, one of them being the Bay Area Pollution Control, which has established a political entity for the control of air pollution in the Bay Area counties. This organization, as distinguished from the joint-exercise type of arrangement, is a separate entity, but, to limit the implications of loss of sovereignty, the organization directors are established through the existing public agencies, who appoint them to a board to make possible some expression of local control by the various members of the organization. This is probably always a very serious consideration in establishing any kind of a super political organization. This control board attempts to do the job that could be done by any one of the Bay Area counties that are suggested to be included within it, and in a sense lessens the effect of this loss of control. This sort of appointive provision is incorporated into many examples of this type of regional development and control in California.

The third type of arrangement which is permissible in California and most of the other states is the development of specific area within an existing public area or public body organization--for example, the statutory development of a new governmental agency within an existing governmental agency. For example, California is divided into 58 counties, and the suggested theory is that one of these counties would be selected as a special type of district giving particular power to the organization, which is completely established by the state legislature. These public agencies normally extend only to the areas within existing public agencies, but specific powers are granted to it under the theory that the existing public agency management simply is not qualified to develop expertise in a particular area, and it would be more desirable to have a special board of directors, even in an existing public agency area, qualified to deal with a particular problem. We have, for example, in many of the counties of California today, a water disposal facility similar to that in Contra Costa County. There is a Contra Costa County flood control and water protection district which extends to the entire district but is managed by a board appointed by the board of supervisors but having particular capacity in interest in this limited problem.

The State of California, along with some 28 other states, provides special types of general authority for the development of political agencies within and including less of the area than is already within existing political agencies. In California this is done by the Health and Safety Code, which permits the creation of sanitation and waste disposal districts. These districts are formed by only part of the county in most cases, and, again, the authority there is not by special act of the legislature but is created under the general laws of the state. These areas extend into management areas for a particular local problem, and in this case the disposal of waste has, again, a separate board, a separate political organization, which, again, is created under the feeling that the existing administrative bodies are not capable of providing the type of controls that are necessary for this particular system.

The problem of waste disposal is recognized as one that must be developed and answered through area management. This problem, of course, immediately presents the political problems of how the management can be established. We must recognize that, when the area extends beyond the state line, we are concerned with interstate compacts, which must be authorized by Congress. In developing and looking at your own state law, you must determine whether any intergovernmental relationship is necessary, and, if it is, whether it is prohibited by state law. If it is, the immediate concern must be eliminating the constitutional prohibition, for such elimination is time-consuming: you might expect some 4 or 5 years to elapse, even with some political pressure, to remove these constitutional limitations. Finally, in the case where there is no prohibition within the state but there is no authority, authority must be created. Examples have been given to you as to the manner in which this has been done in California, and these may lead you to exploring particular means by which local control can be developed. The mechanics are available. It is a simple matter in a sense, except for the element of time, to develop locally the political organization which can make solid-waste management at least politically feasible.

DISCUSSION--Legal Facets

MR. GILBERTON: I have been meaning to check on this thing with our own general counsel's office, but perhaps you might venture some kind of a comment on this. In this new solid-waste disposal act, we have a definition of the term "interstate agency," saying that it is an agency of two or more municipalities in different states or an agency established by two or more states with authority to provide for the disposal of solid wastes and serving two or more municipalities located in different states. Now, the question that I wanted to ask is: Under this wording, would it be necessary to have a formally interstate compact with ratification by Congress in order to satisfy all the requirements, or would this likely be an adequate legal base for us to, we will say, provide grants or what have you?

MR. NEJEDLY: In my opinion, a specific Congressional authority would be required for any compact arrived at pursuant to that general direction which is not, as I understand it, a specific authorization, and secondly, if the relationship is not between the states themselves but between political subsidiaries of the state, the state itself must give statutory authority for those municipalities or counties to enter into an agreement themselves.

MR ARMAJADA: I would like to comment on a potential problem area that might exist in the formation of a sanitary district within an existing, say, county area. It is possible, as you know, that we have a problem in which nobody wants the garbage in his own backyard, and it is possible that, by the formation of such a district, he might declare against the interest of the larger organization as a whole. In other words, I think that the basic legal question is: the district is formed for a given purpose, and does it then have pre-eminence legally over the larger governmental areas?

MR. NEJEDLY: You mean, for example, the 1923 sanitary district--does it have greater power to exercise the powers within that district than the county has to control it? Yes, except for the controls that can be expressed through the planning controls or nuisance abatement by the county, it has the authority to provide the waste disposal sites that it feels are appropriate. In many cases this will provide serious political conflict.

MR. HOWELL: The specific question is this: A county is selecting sanitary landfill site to take care of problems for the north part of the county, and the area lies within the boundaries of a sanitary district that has not exercised its authority to have a disposal area, nor has it exercised its authority in collection. When the site was under consideration for acquisition, possibly by the county or by scavengers, the board of directors of the sanitary district quickly adopted emergency ordinance prohibiting sanitary landfill operations within its boundaries; the only disposal could be by incineration and composting. Now, then, that overthrows the action that has been going on for some time and the acquisition of the site under consideration. Can that be set aside?

MR. NEJEDLY: That's an interesting question. I am not going to win, no matter how I answer it. In that situation I would say that, properly handled, it could be controlled by the county. Although the sanitary district has the powers to do what you say it intends to do, the county has similar powers as well, and where they come into conflict the court would have to resolve the differences. I think that, properly presented and properly disposed of, the case could protect the county's interests.

ENGINEERING FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH

R. F. Weston

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Mr. Roy F. Weston is President and owner of the Roy F. Weston Company, a consulting engineering firm near Philadelphia, specializing in environment engineering problems. His company has planned and supervised areawide and comprehensive wastes management studies and programs for the past twenty-five years.

Mr. Weston is, of course, a registered engineer; he is a member of many professional and technical societies, and serves on a number of local, state, and national advisory committees.

It is rare that an engineer has the opportunity to precede a planner, but it just shows what can happen when contingencies arise. The best-laid plans sometimes go awry. I am supposed to be talking about the engineering facets of solid-waste management. The role of the engineer in this particular field covers a very wide spectrum. It goes all the way from that of the individual who collects the basic data, through research and development, to design of physical facilities, to operations, on to administration.

The engineer may be a representative of various levels of government, of industry, or of private practice. Therefore, it is hard to define what his specific role may be. However, there are two things that are common to all engineers. He is generally a problem solver and he has a strong sense of responsibility to the public.

He frequently finds himself in the position of a coordinator. Not because he has any better skill for coordination than anybody else but because there is more money involved in engineering the facilities that may be provided than in any other technical service part of the program. Therefore, he automatically gets the job of coordination because he has the most money to work with.

This means that in many cases the engineer must be responsible for the approach that is taken. This is the reason I am here. Waste or pollution control has been my primary interest for the past 30 years. This has included, primarily, activities in water pollution control, and, secondarily, activities in air pollution control and solid-waste disposal. This experience has convinced me of one thing. The basic approach and concepts of control that apply to water apply to both air and solid wastes. They differ only in detail.

A basic approach to water pollution control has been in existence for at least twenty years. I can say this because it was about 18 years ago that I co-authored a paper that summarized what we knew a that time. In 1950 an award was received for that particular paper. This means that the concepts of good wastes management are actually quite old. Since these concepts apply across the board, we are not talking about anything new. We are talking about that which is old and proven. Therefore, it seems to me that it would be a good idea to take a look at what has been done in other areas, the approaches that have been used, what experience has been acquired, the successes that have been attained. We should determine just how we might be able to utilize this background of available knowledge.

If we were to take a large multiproduct industrial plant, we would have an excellent model. There are many sources of wastes, and a wide variety. There are different geographical locations, e.g., the plant may be separated by a river or a highway. There are numerous departments, each under a different head and each obligated to make a profit for the company. There are numerous choices for controlling or disposing of waste materials. As a matter of fact, it is not uncommon to choose between discharges to the air, to water, or to land. There is one policy-making and overall management. Actually, the model is in many ways similar to a large governmental unit.

Therefore, let us examine the approach of one company or one industry. The first thing required is a sound philosophy. A sound philosophy proposed by one company was that industry was obligated to provide its product to the public at the lowest possible total cost. Total cost was not just the market price for their product. It was the market price plus such other costs as may result from product manufacture or use, e.g., losses due to pollution. The second philosophical point was that the company or industry should know more about its waste materials than anyone else. And, third, that pollution control must be provided at the lowest possible cost. In other words, the solution should be optimum.

In the case of water pollution control, first it was necessary to determine the source, quantity, characteristics, and mode of occurrence of the wastewaters. The variability of quantity and quality was found to be of prime significance. Next, we were concerned about pollution effects. This involves not alone the effects in the stream itself but the effects within the plant sewage system. There are many interrelationships of concern. For instance, if one wastewater stream is mixed with another, the resultant mixture may be worse than either stream by itself. It was then necessary to be concerned about the water quality criteria that may have been established by regulatory agencies. If water quality criteria were not established, it was necessary to establish the effect of these wastewaters on the various water uses. Special study techniques were developed in several cases. When cause and effect were established, relationships were determined.

There were many cases in which it was necessary to be concerned about analytical methods. Available methods did not properly characterize the materials to be identified. It was necessary to go to the laboratory and develop toxicity evaluation and other analytical tools. Also, special methods for quantity measurement were developed.

After taking a complete and systematic look at the source, quantity, characteristics, variability, and mode of occurrence of the wastewaters, and wastewater effects on water uses, it was possible to define the problem. After defining the problem, it was necessary to consider alternative solutions. This required the development of treatability techniques and practices because many treatment problems had never been solved before. Laboratory techniques were developed and correlated with practice to establish low-cost methods for determining the treatability of wastewaters. After establishing how the wastewater could be treated to meet the water quality requirements, the physical factors of topography, foundation conditions, etc., were considered so that the most economical solution could be established.

In evaluating alternatives, it was frequently apparent that treatment costs were excessive because process losses were high. Critical examination of wastewater sources demonstrated, in many cases, that control at the source was significantly more economical than effluent treatment. Consequently, a check list of in-plant measures to reduce pollution control costs was developed to serve as a guide in making economic evaluations.

Thus, a methodology was developed to achieve optimum pollution control. The approach developed for optimizing water pollution control works equally well for air pollution control. Current studies indicate that it is also applicable to industrial solids-waste disposal problems.

In considering total costs to the company and the public, control at the source has proven to be a highly important factor.

At this particular point in time, someone in the back of the room is thinking, if a system for solving wastewater control problems has been available for 20 years, why do we still have a lot of water pollution? This emphasizes a point that I hope to make. We have heard a lot about systems analysis in the last day or so. A sound system for solving our problems of the environment has been known for many, many years. The techniques used in the past have not been as sophisticated as they are today, but they were just as sound. As a matter of fact, they have provided a basis by which a systems analysis can be made. The important point is that it is not the concept of system analysis that counts. It is the implementation that spells success or failure.

Satisfactory implementation requires essential funding; then it requires sufficient detailed knowledge of the many technical, public-relations, and economic facets of the problem to evolve a sound solution. The public will pay only for that which it wants, i.e., that which in their opinion is necessary and timely.

Systems analysis may aid in establishing an organized approach for research and development so that the technical answers will be available when needed. It may even aid in establishing public education programs. Nevertheless, it is imperative to point out that systems analysis is just another tool to aid the judgment of decision makers. It is not a solution unto itself. The answers obtained by systems analysis are no better than the experience of the analysts in the subject they are analyzing.

One of the major points of environmental control was brought up last night. This point is control at the source. In industry, where a system is under one management, control can be attained at any point from the very source of the waste to the point that it leaves the property. This simplifies the management problem, but does not alter the basic concept. The basic concept is that the best kind of pollution control is to avoid producing the waste.

This raises an important question as to the kind of a system we should be analyzing for effective solids-waste disposal management? I feel very strongly that we should be investigating a system that goes right back to the source of waste material, no matter where that may be. Is there a precedent for this sort of approach; would this unduly interfere with our free economy system? I think the answer is that we do have a precedent and we would not be interfering unduly with our economic system.

It became quite obvious to many in the field, a few years back, that a product was being manufactured and sold that was causing serious water pollution problems all across this country. That product was the hard synthetic detergent. There was no logical reason why the hard synthetic detergent should be causing trouble in many different locations, and creating excessive pollution control expense in a lot of different places, if there was an alternative. There was an alternative. Government and industrial people worked out a solution. We now have legislation, foreign and domestic, to control the use of hard detergents, and industry is participating in a program of phasing out hard detergents in favor of biologically degradable (i.e., soft) detergents.

Control at the source is a basic concept. The people in the solid-waste management field will be missing the boat if they confine their efforts to analysis of a system that assumes that the solids-waste disposal problem starts after something has been discarded.

The solids-waste disposal problem should be analyzed critically relative to solids source, quantity, characteristics, variability, mode of occurrence, interrelationship and pollution effects, so that the problem at any specific location can be clearly defined. Then, disposal alternatives should be carefully evaluated so that optimum solutions can be selected. Although each locality may require its own tailor-made solution, certain aspects of the problem will be common to many localities. Therefore, a broad-base program of research and development should be evolved by governmental agencies, professional societies, trade associations, and others to aid in characterizing wastes, establishing pollutional effects, and evaluating abatement or control alternatives.

Such broad-base studies can provide the information needed to define the need and scope of establishing national policy.

DISCUSSION--Engineering Facets

MR. PURDOM: The question I have relates to the discussion yesterday about the systems approach and your last comment. I take it that you think the systems as developed should consider production of the waste and possible changes there, as well as collection and disposal.

MR. WESTON: That is correct. Obviously, there are many areas in which you can do nothing about the production. Dairy-barn waste, for instance--I doubt if much can be done about the type, the quantity, and the material that is produced. There are, however, large areas in which there is a possibility for control. This isn't original with me, but I can't help being impressed with the illustration of the perfect container for a food product--the ice cream cone. There is no food-container disposal problem. You eat it.

MR. BOWERMAN: In your talk, you have compared technological development with that of water. Could you give us a comparison of technical development in the solid-waste fields. Is there a real resource of information available?

MR. WESTON: I think that, in point of time, the philosophical and technical development of solids-waste disposal is about 15 to 20 years behind water and 5 to 10 years behind air. This is what I gather from the discussions that I listened to yesterday. This may be unjust, because I know that the art is very well developed in many areas, but I do believe this is a reasonable evaluation.

PLANNING FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH

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Mr. Williams is a Californian; he formerly worked in the San Francisco Bay Area as a planner on waste disposal and on rapid transport. This followed his academic training as a planner, obtained at the University of California. Three years ago he accepted the position of executive secretary of the professional organization for planners.

I was interested, and I am sure you were too, perhaps intrigued, by our chairman's earlier description of the symbolism of our conference button. It reminded me of a time several years ago during one of my low-cycle moments, when I designed a coat of arms for planners. In essence, what it conveyed was a picture of crossed purposes on a field of aspirin. It made a hit with my commissioners, but my fellow professionals didn't think it was so funny. Being at least identified as a "cloud-nine" type does have some advantages, however. I do my best work when I am flying about 6 miles high on a transcontinental trip.

When I was coming out from Washington to Sacramento on this last trip, a musical phrase kept going through my head from a very old play on Broadway (I am sure it closed rather early). The first line went like this: "Oh Mabel, ain't it romantic sitting here on the wharf, watching them haul the garbage out to sea." You can probably see why it didn't make a big hit on Broadway.

The notion that ancient civilizations built new and inspiring cities on the rubbish and ruins of earlier urban societies may also have a romantic ring to it, but for those individuals and organizations concerned with contemporary solid-wastes management, the prospect of history repeating itself has frightening implications.

The importance of adequate solid-wastes management to urban environment and to man's capacity to act creatively, as an individual and in concert with others, in that environment must be underscored by this conference.

The scope and apparent complexity of the solid-waste problem surfaces in every area of human activity. It does so most dramatically in our metropolitan areas. It is of fundamental importance that the general public and responsible local elected officials understand the urgency of the problem and the need, quite frequently, for a metropolitan approach to its solution.

As a planner, I must confess that our profession has not always been sensitive to this urgency. Facilities for solid-wastes management have often been an overlooked or de-emphasized aspect of local community facilities planning. In this regard, their history parallels that of churches and cemeteries and other somewhat controversial aspects of urban development. Yet, the frightening pace of solid-wastes accumulation in our urban centers, like the proverbial salt machine, grinds on and can no longer be discounted in the consideration of local and metropolitan development policy.

Wes Gilbertson, who I am delighted to see on this conference program, has said: "In the long run, solid waste problems cannot be solved by minor adjustment in and perfections of the methods of yesteryear." I agree with Mr. Gilbertson. In yesteryear, local government action on urban problems has occurred with disturbing frequency in response to crisis or mounting public indignation. Often, the actions taken have been unilateral, single-purpose, and in the long run an expensive postponement of the type of program required to do the job.

If I do nothing else in this paper, I want to urge the metropolitan areas of America to stop pushing the same old peas around on the plate. We need creative, bold breakthroughs in cooperative action, and we need them fast. I don't have to mention to this audience the implications of growth. The simple fact is that, over the next 35 to 40 years, we are going to commit to urban purposes an additional amount of land equal to that now occupied by the communities of our country, an urbanized land area that took some 350 years to develop. We are going to double our amount of urban land in the next several decades. We don't have time to push the peas around on the plate.

I will only touch in passing upon the important question of public versus private control of solid-wastes management. Fulfillment of long-range public goals is the stakes. This issue, however, is beyond the purview of this brief paper, and perhaps beyond that of the author.

On rare occasions, planners do keep their mouths shut and their ears open. This novel exercise has brought me to the conclusion that we have about reached the edge of public tolerance concerning solid-wastes disposal. Now, this fact may hold an element of hope, however, since there is considerable correlation between public indignation over a measurable urban problem and the public's willingness and capacity to finance a positive and aggressive solution. I can give you two cases in point: the East Bay Interceptor Sewer Program in the Oakland-Berkeley-Alameda Area of the San Francisco Bay Area, and the San Francisco Bay Area Rapid Transit System. You could also add, for good measure, the California Water Development Program. All three were public responses to measurable problems.

From a planning standpoint, the problem of solid-waste management involves two areas of coordinative action: interprofessional and intergovernmental. Interprofessional teamwork is essential to technical innovation and research. Intergovernmental teamwork is the key to effective implementation of a well conceived solid-wastes management plan and program, both statewide and metropolitan.

I have suggested that a sense of urgency regarding this problem be instilled in the general public and the elected official. I would now like to suggest that we, as concerned professionals, give priority to the quality of urban environment and the criteria and standards essential to its preservation and enhancement. Our environment must become an area of vital public-policy concern.

Over the years the courts have established the relationship of public and private property rights. Not enough has been done, however, in the relationship of property rights to the broader implications of urban environment and urban values. Central to this question is the primacy of public interest, a situation which often pits one public development or standard against another. As examples I would suggest the south bay of the San Francisco region, where the shoreline recreation issues come into direct conflict with the treated sewage outfall programs in terms of standards and utilization.

Frequently, the competition for urban land has involved just such a cut and fill in public policy development and the weighing and selection of public goals and priorities. As a process, this is not necessarily bad. There may be, however, long-range public values inherent in the multi-purpose approach to solid-wastes management. I am particularly struck by the land reuse opportunities afforded by the cut-and-cover sanitary-fill method. Such programs help make the best of present solid-waste management techniques, but they do not provide the technological breakthroughs that are suggested by the purposes contained in the Solid Waste Disposal Act of 1965 (Public Law 89-272). This important federal act has many commendable features, but from a planning standpoint I'd like to concentrate my comments on Section 206, regarding grants for state and interstate planning. We should applaud the emphasis given in the act on focused responsibility and the prerequisite coordination that closely relates solid-waste planning and programs to comprehensive statewide, regional, and local planning activities. Major functional programs such as the one we are discussing at this conference must be fitted into the public-policy matrix as an important element of efficient and desirable urban growth.

Through the research stimulus of the Solid Wastes Disposal Act of 1965, I can visualize 2 types of technological breakthroughs occurring. The first could be described as frontal, a direct attack on problems of solid-waste disposal by the application of new tools and innovative techniques. I would ask you to stretch your imagination a bit as to the prospects and the potentialities of some of these things that I am going to mention. For example, take the fuel cell. Now, the fuel cell has made planners nervous because of its potential impact on physical environment. You could take a fuel cell, perhaps the size of a microphone, plug it into a domestic system, and effectively operate a self-contained housing unit. This means that the umbilical cords of conventional utility-line extensions would be broken. Housing location would then be a function principally of our ability to transport ourselves to and from that housing, and perhaps of the sociological and psychological requirements of clustering together for the human interactivity that group living affords. Technically, however, the fuel cell could have dramatic effects on housing design and location, our journey to work, and the relationship of industrial-commercial-residential areas. It could have dramatic effects on the work week and production, perhaps to the point where we have a 3- or 4-day work week--an A work-shift and a B work-shift rather than all of us working the same 40-hour week.

I would underscore the processing of solid wastes at the source where the fuel cell again has obvious implications for residential, industrial, and other land-use activities.

The second technological breakthrough might occur in areas of human activity related to the characteristics of solid wastes such as nutrient food packaging. Our most classic example is the efficient ice-cream cone. But in the coming days of ultra-high-frequency cooking I see no inherent complications in having the packaging become a tasty additional ingredient to the packaged food itself. I think we can make technological progress in the area of what I would call "nutrient food packaging."

I think, in the recycling of junked autos, we have technological breakthroughs yet to come. Also, how you and I take a bath every day (or maybe once a week) is going to change. I would anticipate that future bathing will be in foam or foamite; and this, from a health standpoint, would perhaps be much better for us than the traditional soap and water bath, which leaves somewhat of a film, they tell me, even under the best conditions. We'll all be drying off with compressed air, and for the ladies we'll put a little cologne into the system.

The third area of technological breakthrough, I hope, will occur in product storage and distribution techniques. We can come up with better systems, something better than just modest improvements to our present techniques. Again, this ties back to some of these other primary breakthroughs I mentioned earlier.

We're not sure what the juxtaposition of land uses in metropolitan areas is going to be over the next 50 years. A lot of hip-shooting is going on in the field of planning, just as in the area of solid-wastes management. I'm therefore suggesting that we concentrate our research efforts toward predetermined solid-wastes management goals. This idea is not unique. American technical capabilities have reached a point of sophistication and teamwork whereby we can actually program inventions. We can set up goals and target points, and we can apply our resources in such a manner that we can actually program technological breakthroughs and scientific advances.

In the meantime, however, Rome burns. Perhaps we need a comprehensive environmental monitoring system that operates both statewide and in many of our metropolitan areas. Such a monitoring system would offer a useful and defensible alternative to the current tendency toward specialized, single-purpose monitoring. The advantages of collecting comprehensive environmental data, the opportunities for coordinated planning with state, regional, and local planning agencies, and for closer relationships to the planning and development of transport and open space networks should be readily apparent in this type of comprehensive environmental monitoring approach.

Solid-wastes management would be an important aspect of such a comprehensive monitoring system. The system would serve the greatest public purpose by helping establish environmental standards and regulations that reflect metropolitan and statewide comprehensive development policies. The burden is upon elected public officials, of course, to provide an adequate policy matrix within which these standards and regulations could be established. The key is an integrated system operating, in effect, within a broader integrated system.

For all our good intentions--and the new legislative, intergovernmental, and technical research tools now within our grasp--the fact remains that solid-wastes disposal problems still plague us and grow more acute each day. The technological breakthroughs, the monitoring systems, and the other possibilities I've suggested so glibly today will cost money, probably a great deal of money, but the challenge before us is prophetically similar to the oft-quoted phrase heard during public discussions on the recent San Francisco Bay Area Rapid Transit bond issue: "It is not a question of whether we can afford rapid transit, but more a question of whether we can afford not to have it." This same admonition should be applied to our future stance and activities in relation to solid-wastes management.

DISCUSSION--Planning Facets

MR. LINSKY: Bob Williams and I have worked together long enough that I think we can operate together this way with a comment and a question. Bob, wouldn't you agree that you have not adequately presented the fact that air, water, and solid-waste disposal planning and programming are quite different from each other? The particular factors I'm thinking about are that, in water, you have a very limited number of emitters as a receiving body and you don't have to go into the water if you don't want to, so the exposure is a selected exposure with pretreatment before you have to use this if you insist on it. If you insist on drinking, etc., it will be treated for you. In solid wastes we have the unpleasant appearances of some of the temporary on-site storage methods, particularly the curb pick-up collections, curb pick-up accumulations, plus the littering that was talked about; but, basically, you have a centralized collection disposal for most of the solid wastes. In air you have millions of emitters right to the receiving body, which cannot be pretreated and which no one can escape. I wonder if you would agree with these differences, and therefore differences required in planning approaches.

MR. WILLIAMS: Yes, I would. In response to the question that preceded your statement, Ben, I did underplay it. I didn't have the time or the qualifications to go into it.

MR. LINSKY: There are some other factors--for example, the East Bay Municipal Utility District. Somebody put together a package that had some special clientele, some contractors, some consulting engineers. Weren't those the additional allies that were needed?

MR. WILLIAMS: Oh yes, but when the moment of truth came it was the electorate that had to vote on the issue, and they had to be convinced. In the same sense, so was the 60% vote on the Bay Area rapid-transit bond issues. You had to convince nearly two out of three people that 2½ million people should incur a bonded indebtedness of nearly $800 million, or over $300 per capita. Now, that's motivation. You've got to really reach people on an issue like that. That's why I dwelled on those two rather dramatic examples.

MR. LINSKY: But there were special clientele to help sell that?

MR. WILLIAMS: Oh yes.

MR. HANDORF: Back a number of years ago, planners and their textbooks always indicated playgrounds and recreation and campsites and all that sort of thing. Where you are, up there at headquarters, have you noticed an indication in new textbooks of any trend toward locating sewage disposal facilities, sanitary landfills, and all these problems we're talking about in environmental sanitation? Most planners have overlooked that in the past. They take care of roads and highways and trees and all that sort of thing, and these other facilities that this group is talking about are never mentioned in the textbook. Is there a trend?

MR. WILLIAMS: Yes. A lot of it, I think, is through some of the federal action in the community facilities program. Maybe it's because planners have to plan with money where there were the opportunities to implement these plans rather than to do them for academic values. And I think we are encouraging a trend toward more attention to this. You're soon going to get into what they call the PPBS, the Planning, Programming, Budgeting System in communities. They're getting into it in Milwaukee; San Francisco is studying this type of planning and development system. So is New York State. Every federal department is going to be operating under this type of planning, programming, budgeting system to one degree or another. This is, in a sense, providing a recognition of the interdependency between planning and implementation. And if plans aren't capable of being carried out, they aren't valid plans. I think we'll begin to find this particularly true in community facilities planning.

MR. WALSH: I would just like to hear you elaborate a little bit more on how you feel about the necessity for integrating planning with wastes management that the last gentleman reflected on.

MR. WILLIAMS: Is this a question of necessity of integrating planning and development?

MR. WALSH: Yes. I felt he made a distinction between these which sort of set them apart and put them as separate little parcels and packages, and yet this is inconsistent with your own presentation on the integrative planning approach being necessary. I would like you to just reflect on that a little more.

MR. WILLIAMS: We may be getting into a little bit of a semantics problem here; I suspect we are. But our definition of planning is that comprehensive planning includes three essential elements. Basically a land-use plan element, perhaps a transport-plan element, and more recently a community-facilities-plan element. These three, in turn, break down into several subareas. In the community-facilities-plan element, we find that solid-wastes disposal sites, both local and regional, etc., are included. But, the fact that they're broken down this way, for comprehensive planning purposes, doesn't minimize the importance or the integrity of such subplans, or what we would call functional plans. Community facilities are an essential element, an essential part, and without that part the plan is faulty and incomplete. What we're after in comprehensive planning is a long-term public-policy focus, so that there is a basic direction and consistency to every public and private action taken, not just fighting the municipalities or the governmental agencies involved. We must provide a matrix of public policies which private enterprise can look to for guidance to know what their investments are going to be, where they're going to be, and to be assured that their investments are adequately protected. This is what makes the world go around.

MR. KAPLOUSKY: I've heard Mr. Weston speak of one phase of water and air and the association and relationship to refuse. I'll use this term lightly. And another position taken by a gentleman here that seems to differ is that these three are quite closely related. I would just like to make a comment that the trends, in our waste systems, have been catching up to us in the last 5 or 10 years. I do not see how we can separate refuse from waste disposal and solid disposal. We've got many new ideas and patents, particularly in metropolitan areas in various skyscrapers that are going up, in which they wish to grind all their paper into a fine pulp and distribute it into our sewage system. So we were never worried as recipients of quite a bit of this refuse. Our unit load of pounds per capita is already doubled in one respect, and it can go much higher. So I think that we all have an ultimate disposal problem and it is in the solid form. To a lesser extent I think the same thing applies to an air pollution problem. Whether you have precipitators to get your solids out of the atmosphere (your particles), you still have a solid-disposal phase, whether you scrub it out and they put it back into our sewer system in a liquid form or a colloidal form, which again is made into solids. So I think that, no matter how we slice it, pollution is pollution, and it all ends up in a solid form. I think of the old adage about waste treatment itself: You're only as effective as your solids-handling capability. And this applies, I think, very much to waste and to many other problems that have wastes or solids for disposal.

POLITICAL FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH

J. L. Witherspoon

Budget Officer
Anne Arundel County
Annapolis, Maryland

Mr. Witherspoon is a practicing political scientist. He has worked for a municipal management consultant. He then became Research Director and Assistant Secretary for the National Association of Counties. He served on a number of training programs in waste management while with that organization. He recently returned to the grass roots, and has become the Budget Officer for the county in which Annapolis is located.

It is only through association that I am even remotely qualified to speak on the integration of political facets in solid-wastes management. I have never held elected public office--or even run for one. In fact, other than by casting my ballot I have never participated actively in the electoral process. Likewise, I am not a sanitary engineer, nor an engineer of any sort--even when it comes to the most simple of common household mechanical breakdowns, as my wife will be all too ready to testify. Therefore, being neither politician nor engineer, I am eminently qualified to present this paper--on the basis of objectivity.

There is also a matter of association. During the last three years my work, both with the National Association of Counties Research Foundation and with Anne Arundel County, has brought me into contact with politicians and professional engineers from many sections of the country. My duties as Research and Urban Reporting Services Director at NACO encompassed several large-scale projects involving various aspects of environmental health. We approached these areas from the viewpoint of what local elected officials can and should do to prevent the pollution of land, water, and air. The fruits of this labor are being published in the form of Community Action Guides for local officials. NACO has finished the guide for water pollution control, is in process with the air pollution control guide, and is awaiting a more munificent nod from its partner-benefactor in these efforts (the U. S. Public Health Service) before starting the solid-wastes program.

In sum, I don't know whether this association makes me more qualified to speak on political facets of solid-wastes management, or just less objective.

My approach today will contain an assumption that we are all professionals involved in the various managerial roles of solid-wastes management. In performing our tasks we are confronted by political facets eminating from two general sources--the public and the working politician. The subject here will concentrate on the politician and how the public relates to our performance through the politician.

A definition of politics is probably appropriate here, but the word is so subject to misuse and abuse that some general comments will have to suffice. Politics as a career affords some of the best and some of the worst of human experience. A politician, at any one and the same time, is a great statesman and ward-heeler, a humanitarian and a gross manipulator of people, a benefactor of public institutions, and a "wheeler dealer." In short, the politician's life is so intertwined with all that is good and all that is bad in human nature that we, the professionals, are at once jealous of his responsibilities and abhorred at his working conditions.

And it is for him or through him or in spite of him that we, the professionals, must seek to do our job. Because of our great dependence on the politician, we had best understand what makes him tick.

This analysis of politics and the politician can be viewed from three areas: politicians themselves, characteristics of local government, and citizen response to local political issues.

The most difficult thing about politicians is finding one. Especially at the local level of government is there a great reluctance to identify oneself as a politician. In truth, everyone who has ever sought public office has been a politician, even if only for a short time. The undesirability of admitting to being a politician is a national characteristic that is akin to another characteristic of American politics, running for public office while pretending not to and pretending not to want the job. Remember the statement attributed to General Sherman: "If nominated I will not run, if elected I will not serve." This, more than his march through Georgia, almost made Sherman worthy of becoming our 19th president.

With respect to local politicians, we can recognize three general types:

1. The single-minded office holder
2. The non-leader
3. The performer.

Quite often the most dangerous of the three types are single-minded office holders. They run for office for one purpose, with a sort of devil-may-care attitude toward other issues and their re-election. In short, they will largely ignore all issues except their one interest, which, incidentally can be either positive or negative, and they don't intend being around when the results of their singleminuedness become clear. Politicians of this type often catch the "bug," so to speak, and become politicians of the performer-type; single-minded politicians usually are too strong-willed to become non-leaders.

A useful characteristic of the single-minded office holder is that his singlemindedness can be preyed upon to get other things accomplished. A leading southern-state legislator once related to me that the single-minded types were useful to him in guaranteeing the success of the administration's program. In a complicated process of "log rolling" he would guarantee the "cause boys," as he called them, a certain amount of support for their individual projects in return for general support of administration programs. The end result was that he would pull the "cause boys" together for the administration and allow them just enough strength to put up a good show in the interests of their individual causes. His greatest triumph, he added, was in arranging identical votes against two bills, one that would have extended deer season two weeks, and the other which could have eliminated it entirely.

We commonly refer to office holders as political leaders, but there is a vast difference between leading and being pushed. The non-leader type of politician needs pushing. Usually, he is very interested in retaining his office or moving onto another one, but keenly aware that it is much easier to go along with the voter than it is to change the voter's direction. Unlike the single-minded type, the non-leader is actively interested in a wide range of issues. His interest in solid-waste disposal, like all of his interests, is conditioned to visible proof of which way voters are going. If he can be convinced that a particular course of action is popular, his support is guaranteed.

An important thing to remember about the non-leader is that one's sense of political desirability may become dulled with time and changing political environment. This fact was brought home to me some time ago when the legislator mentioned above was retired by the voters in his county from further legislative responsibilities on their behalf. As he put it, "I knew things were changing but I misjudged the speed of change." As professionals interested in advancing our areas of public services, it sometimes behooves us to keep our non-leader leaders aware of the speed and direction of changing public needs.

The remaining type of politician usually requires no such intelligence from us. This is the one I've labeled the performer. A performer is one who is doing his job, in this case being a true political leader. His motive is immaterial. He can have higher political ambitions or he may be more concerned with getting out of politics, to attend more fully to his neglected business or profession. In any event, this is the type of politician who not only will lead a cause but also will take one to the public. Given a legitimate public program such as tighter controls on solid-waste disposal, the performer-type will take it to the public, with or without initial public support.

All is not roses for the professional, however, when confronted by the performer. The performer can be very exacting in his demands on the professional. Being uncommitted to any one cause and not easily persuaded by isolated demonstrations of public support, he needs convincing through a rather comprehensive process of justification. This is the councilman at a budget hearing, who will leave concern over the relative expense for desks in departmental requests to his colleagues, while he offers probing and sometimes embarrassing questions about apparent inconsistencies and duplication among departmental programs.

Turning to the characteristics of local government, let us consider authority, structure, and age. Authority and structure are, to a very large extent, determined by state constitutional law. Unfortunately, laws now in force are antiquated, especially with reference to county government. Most local-government laws were designed to prevent concentration of political power, and today stand in the way of political responsibility and the provision of needed public services. The situation varies from state to state; however, it means that in any given community the technically ideal method of providing solid-waste disposal may be impossible, because of such things as lack of specific authority, limitations on tax rates and indebtedness and inadequacies in administrative structure.

The aging process in county and most city government is unusual in that they are now old but still have to go through adolescence before reaching maturity. County government in a few states, for example, hasn't changed basically since colonial days. In these counties, business is as usual in the courthouse, and no one is looking to change things. In actual numbers, many counties have little need for changing.

But in the five hundred or so counties affected by urban growth, changes are taking place extremely rapidly. These are counties that either have gone through or are going through their second childhood.

The problems of waste disposal in these jurisdictions have stabilized around issues of improvement in mature jurisdictions, and are chaotic in adolescent jurisdictions. This is further complicated by the fact that, while politicians in mature jurisdictions are usually either of the performer or non-leader type, people who seek to satisfy public needs with either greater or lesser enthusiasm, political figures in adolescent jurisdictions, tend to be of all three types. Adolescent jurisdictions are also affected by a high incidence of turnover at the polls. Quite often a pattern develops whereby a jurisdiction changes from non-leaders to performers and then to single-minded office holders whose single-mindedness is in cutting taxes. Many a soundly begun refuse program has floundered for this reason.

The key to successful local government lies in carefully maintaining good citizen response to public issues. We devoted a lot of effort in the early history of this country in designing laws to prevent bad government. In so doing we erected barriers to good local government. All the time, what we should have been doing is developing the means by which citizens are kept adequately informed on public issues and public institutions.

But we haven't--so we must do it now on a piecemeal basis. We have to find means of making the citizen understand in spite of all the other demands upon his attention. The first thing we must do in seeking citizen understandin of solid-waste disposal problems is to stop using that phrase. No, this isn't professional heresy; it is simply practical politics. Show me a politician who talks of both solid-waste disposal and waste-water treatment before a group of average citizens, and I'll show you an audience that thinks he has discussed only one subject. People understand sewage, garbage, and trash, but terms like waste-water treatment, solid-waste disposal, and environmental health somehow miss the mark. Try them out on your neighbors, as I have, and you'll become as disenchanted with these terms as most politicians have.

"Garbage" and "trash" are strong words, and are usually considered by citizens in two ways. First, they want collections frequently and regularly, and second, they want disposal to be out of the range of their senses. These are reactions so strongly held that even a suggested violation of them can get an angry crowd down to the courthouse faster than a promise to cut taxes.

What we must do is to guide this interest into useful and constructive channels. A good start is to interest groups such as the League of Women Voters and other service organizations interested in the problem of solid-waste disposal. Once convinced of the magnitude of the problem, they will begin consuming all of the relevant material you can provide them and translating it into a form that voters can easily comprehend. The interest of local political officialdom will also heighten considerably when they learn of this new interest of the local league.

The proper means of being successful in the politics of solid-waste disposal has many facets which exist in varying degrees in different communities. Obviously, not all of these facets can be discussed at this time. They can be summarized, I think, by repeating a statement made to me by Alan Keipper, Manager of Fulton County, Georgia: "Successful public programs are achieved by the professional in any field only when he tempers sound technical judgment with commonsense. The best disposal site technically may be the poorest politically. Good sense might well dictate settling for the second- or even third-best site." All of us have a little of the "Moses complex" in us. Robert Moses, as you are quite aware, has achieved much success, for good or bad, by figuratively spitting in the eye of politicians and politics. But I would conclude by reminding you, if you'll pardon a slightly mixed metaphor, for every Moses in the ranks of professional public servants there are thousands of martyrs who will never reach sainthood.

BUSINESS FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH

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Mr. Balden is much concerned with in-plant waste management from industry, being in charge of waste disposal from one of the automobile manufacturers.

Recognizing the impact that wastes have upon the environment as a whole, he serves on the Michigan State Chamber of Commerce Water Resources Committee, and is a member of the Governor's Task Force on Water Resources in Michigan. He is the automobile industry's representative to the National Technical Task Committee on Industrial Wastes, an industry-promoted organization dedicated to managing wastes to reduce their insult to the environment.

In Lewis Carroll's poem "The Hunting of the Snark," these lines appear:

> "He had bought a large map representing the sea,
> Without the least vestige of land:
> And the crew were much pleased when they found it to be
> A map they could all understand."

I'm sure that this must mean several things. Among the interpretations would be a warning about the dangers of oversimplification. The real significance of most topics is appreciated when they are considered in the context of interrelated subjects. Studies of water pollution and ultimate disposal take on full meaning only when considered in reference to man and his total environment.

Any use of water leaves a record of that use. Civilized society demands that this record be erased to the extent that is feasible. Ethical considerations require that those responsible for pollution take remedial action. Technical evaluations of waste-water treatments show that, as a rule, treatment is more effective and economical at the source of contamination than when the waste becomes more dilute but with many other contaminants present. There are exceptions, however, such as certain types of biodegradable organic wastes which can be effectively treated in municipal secondary treatment plants.

It is a rare product, indeed, which can be produced without waste. This waste may be in the form of scraps of material, such as metallic scraps, which, in a sense, constitute a temporary waste since they can be remelted for reuse. The waste may be a plume of gaseous exhaust, but usually it is the water used in processing and it has become polluted. Our company accepts the principle that the treatment of industrial waste waters to the degree necessary to protect the nation's waterways is a necessary part of the cost of doing business.

Our nation was slow to recognize that our supplies of fresh water were gradually losing their quality. Shortly before World War II, some studies indicated the necessity for taking corrective measures, but the war intervened and it was not until 1948 that significant legislation was passed. Early measures were exclusively focused on removing whatever was causing the water to be polluted. This program has now received the attention of all segments of the population, and extreme corrective measures have sometimes been applied. The sophistication of many of the antipollutional activities now recognizes that removing a waste from a stream of water is no longer enough. It is essential that this pollutant be prevented from again reaching the aquifer. Current practice in most parts of the country allows the use of open dumps for disposal of a great variety of municipal and industrial solid wastes. Restrictive legislation based on a due concern for ground-water supplies as well as a serious and worsening shortage of suitable and convenient sites, due to population growth, has challenged industries as well as municipalities to find a more nearly permanent solution for disposal of these wastes. Many of the technical problems pertaining to the cleaning of industrial waste waters having been solved, we now face the problem of ultimate disposal.

Good water management requires recirculation and multiple use of the water supplies. Avoiding wastes by removing contaminants that interfere with continued use of a water solution or emulsion reduces the volume of

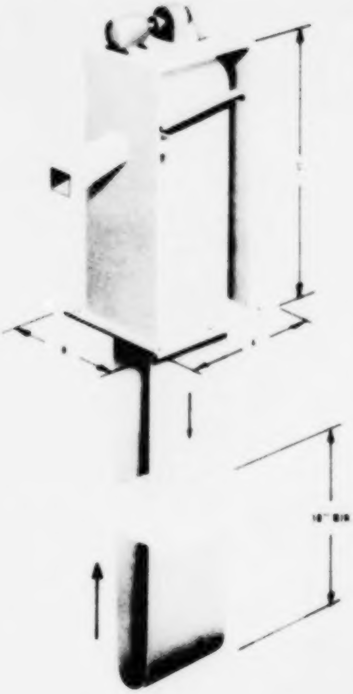
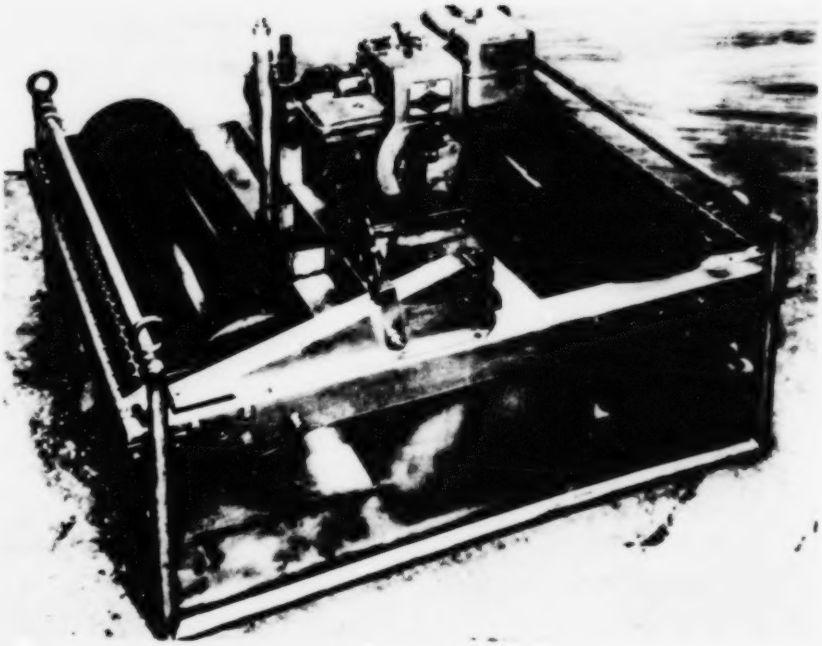


Figure 1 BELT SKIMMER

Figure 2 DRUM SKIMMER



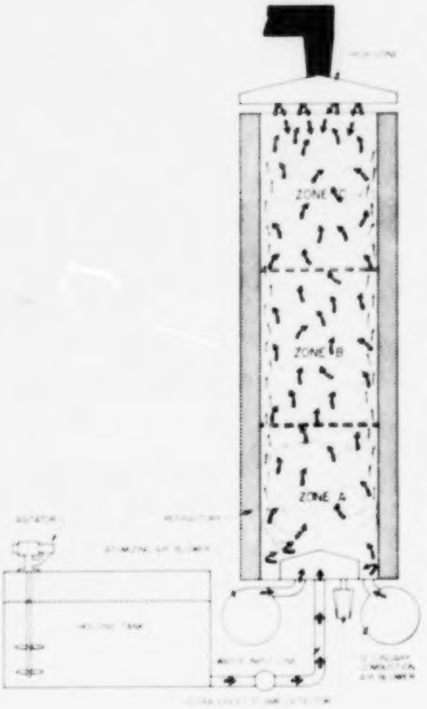
wastes but not the magnitude of the technical problem. Examples of this are: 1) in-process filtering of cleaners to remove fine particulates which could otherwise redeposit on the work being cleaned and, without filtering, would require more frequent disposal; and 2) skimming or centrifuging to remove free "tramp" oils from soluble oil coolants. It would be ideal if further treatment of the wastes would produce a product which could be sold or reused. Free-floating oil can be removed from primary treatment tanks by means of a belt or drum skimmer at a purity of 95% or better, making feasible its reconstitution and reuse as machining oils or soluble oil coolants.

The simple soluble oil formulations can be separated readily into their oil and water fractions by sulfuric acid destruction of the emulsifier. However, most soluble oils or emulsion cleaners are considerably more complicated and usually contain a combination of emulsifiers to provide increased stability and longer life to the emulsion. These emulsifiers do not all react in the same manner, and treatment with acid and such trivalent ions as the aluminum, Al^{+3}, or the ferric ion, Fe^{+3}, results not in a neat two-phase separation, but in three phases. These three phases are: 1) the aqueous phase, containing the solution of the trivalent salt and the now dilute acid; 2) free-floating oil; and 3) an intermediate layer between the oil and water consisting of invert emulsion and extremely fine particulate matter of metallic and nonmetallic origin. The free oil has some potential value and the acidified water can be reused, but the intermediate layer represents a useless oily sludge which requires ultimate disposal.

Another material requiring ultimate disposal is paint waste sludge. The air leaving a paint spray booth is washed by being drawn through a water curtain. To make this water capable of scrubbing paint from the air stream, certain combinations of alkaline chemicals are added to the water. This water, laden with paint, is collected in a large holding pit in which the paint rises to the surface and is skimmed for disposal. The water is then recirculated to the spray booths.

The skimmed paint is caught in drums or in tilt trucks. As originally removed from the water wash solution, it is in the form of curds. However, after a while these particles coalesce and form a large, sticky mass with the consistency and viscosity of modeling clay, making pumping impossible. These two types of wastes, oily sludges and paint overspray, constitute the materials most often demanding ultimate disposal by automobile manufacturers.

Ultimate disposal is considered to be that process by which a potential contaminant is made innocuous or removed from possible contact with ground


ZONE C
ZONE B
ZONE A
REFRACTORY
HOLDING TANK
SECONDARY COMBUSTION AIR BLOWER

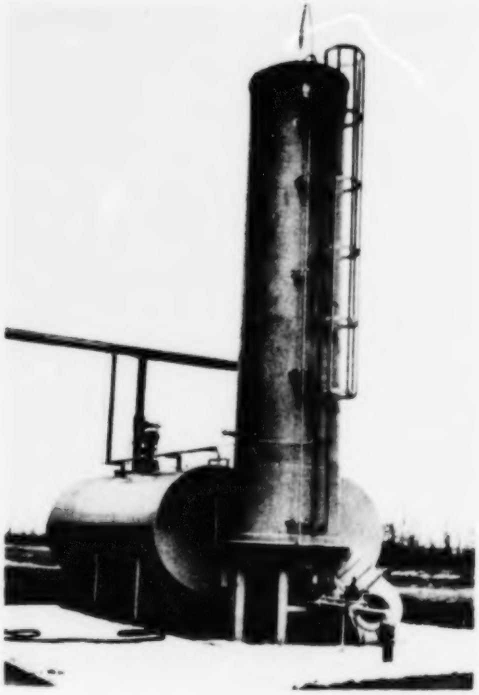


Figure 3 NOZZLE-TYPE INCINERATOR Figure 4

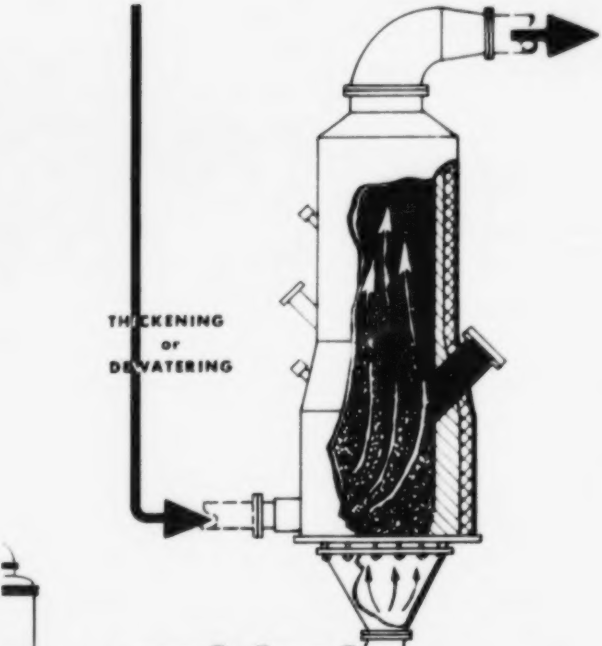

THICKENING
or
DEWATERING

Figure 5 FLUID-BED INCINERATOR

waters. The Environmental Health Series "Summary Report, Advanced Waste Treatment Research" (U. S. Department of Health, Education, and Welfare, Public Health Service, AWTR-14, April, 1965) lists the following five methods of achieving ultimate disposal:

1. Subsurface storage in cavities or pervious strata sealed against leakage.
2. Conversion of the wastes to innocuous compounds by oxidation or other chemical reactions.
3. Surface storage in isolated locations in ponds sealed against leakage and leaching.
4. Disposal of the unconfined wastes into the ocean, where they would be diluted to negligible concentrations.
5. Conversion to useful products by mixing or combining with other materials for use as construction materials, chemical raw material, or other usable products.

The most obvious danger associated with the injection of concentrated wastes to underground strata is the possible contamination of ground-water supplies. Detailed information is essential concerning the geological formations before this method can be considered. If the structure is such that a suitable porous underground formation is separated from water-bearing strata by sound impervious strata, it may be possible to sink a pipe and seal it sufficiently to protect the ground waters. It is quite evident that this is an expensive undertaking and is most feasible if an underground cavity and access thereto already exist, as in the case of a worked-out well or mine.

The conversion of wastes to innocuous compounds by oxidation or other chemical reactions appears to offer the most hope for implementation in the near future. An installation is currently in operation incinerating oil in water wastes to a gaseous exhaust. Studies are under way to determine what problems may be encountered in the incineration of oily sludges resulting from the treatment of emulsions. Among the variables being evaluated are: 1) the point of mixing the waste materials with the auxiliary fuel; 2) the economics of flame versus fluidized-bed incineration; and 3) the nature of the gaseous exhaust.

It is essential that the temperature of incineration be adequate to allow for completion of the reaction by which carbonaceous materials are oxidized to carbon dioxide and water. The light petroleum fractions constituting the fuel in the industrial wastes to be incinerated from a machining plant will burn without a visible plume at 1200°F. If a flame incinerator is being

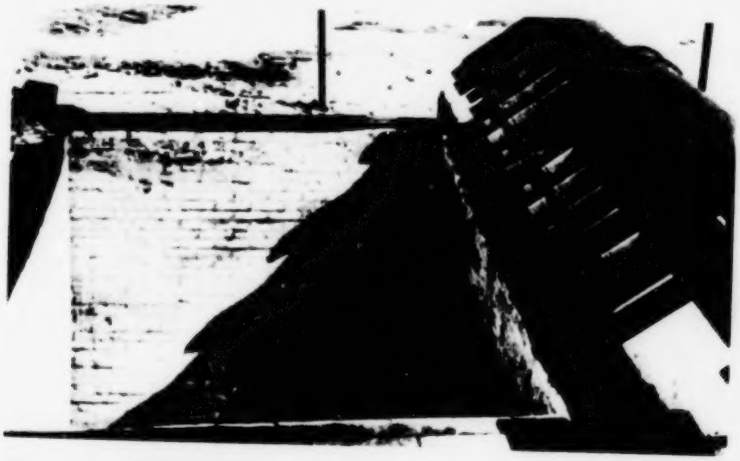


Figure 6
PIT
INCINERATOR
Combustion pit
and row of
air jets

Figure 7
PIT
INCINERATOR
Pit in operation

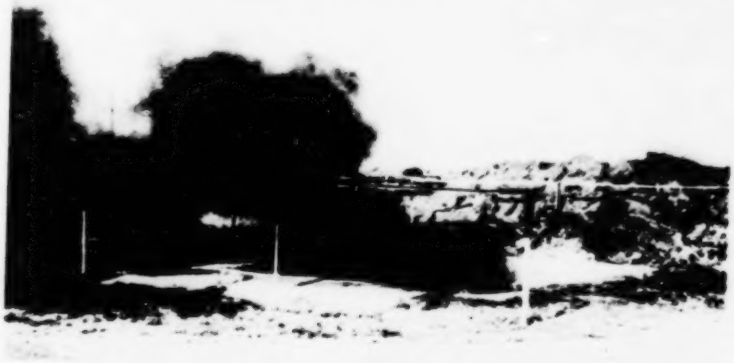


Figure 8
PIT
INCINERATOR
Nylon
burning-fan
off

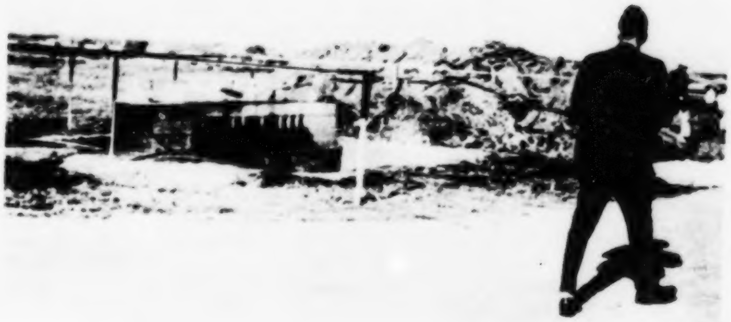


Figure 9
PIT
INCINERATOR
Nylon
Burning-fans
on--
no smoke

used and the waste and auxiliary fuel are being mixed before ignition, it is essential to provide thorough mixing of the oil-rich waste water to avoid killing the flame with a fuel-lean stream. This can be avoided by overfeeding with auxiliary fuel to always maintain a flame. Maintaining the temperature a few hundred degrees above the required minimum also provides a safety factor. Mixing the auxiliary fuel with the waste stream prior to ignition is probably satisfactory if the waste liquid generally contains enough fuel value to maintain incineration. Particularly in those instances in which the waste has a low calorie content, raising it to the flame temperature of 3000°F is wasteful of fuel. Another evident weakness in this procedure is that atomization and complete mixing of waste and fuel is accomplished by nozzle design and forced pumping through restricted apertures. Plugging of these nozzles is a serious problem if any particulate matter is present.

Another variation of the flame incinerator under investigation is one in which the flame is developed with the auxiliary fuel and the waste stream is impinged upon the developed flame. In this instance, the waste is brought to its incineration temperature and depends upon the length of the combustion zone for complete mixing and oxidation. The restrictive nozzle opening is avoided, and more flexibility is allowed in the waste-stream characteristics.

The fluidized bed appears to offer considerable promise for many types of pumpable wastes. In this unit, a bed of sand is fluidized by the passage of air. This fluidized bed and the firebrick lining are heated to the ignition temperature of 1400°F. The waste stream is pumped onto the bed, and good incineration is maintained by regulating the air, waste, and fuel input to maintain the above temperature.

Each of the three above variations in incinerator design is currently under careful investigation. Visually, each is capable of burning an oily type of waste without objectionable emission. The studies will determine the exact nature of the stack gas effluent and the amount of fuel needed to incinerate a gallon of waste.

Incineration of the paint sludges poses the additional problem of materials handling. The above instances of materials to be burnt lend themselves to a continuous process, but, because of its physical characteristics, a paint sludge would seem to require batch incineration if incineration is to be used.

A very encouraging approach to the incineration of solid or semisolid wastes has been used by an eastern chemical manufacturer. This is called a pit incinerator and is extremely simple in concept and operation. It consists of a rectangular pit with the walls lined with firebrick. Air is directed on the flame in a manner to retain the particulate products of combustion in the pit and at a rate sufficient to obtain complete combustion. This unit has been used successfully to incinerate various types of synthetic organic materials and will be thoroughly evaluated for the disposal of paint wastes.

Other possibilities being considered for paint sludges include: 1) polymerization by heating to a temperature and for a time equivalent to curing paint; and 2) disposal to a suitably licensed dump. The latter will have specially prepared impervious holding areas and, because of the considerations mentioned earlier, can be considered as only a temporary method, to be used until a more suitable one is developed.

Proximity to an ocean is an obvious requirement for using the tremendous diluting potential of such volumes of water. Other considerations would include tidal characteristics. Washing of a waste onto a beach would have to be avoided.

The ability to convert a waste into a useful product is an enviable circumstance. This does not happen often, but one source of monosodium glutamate is sugar beet wastes. The "Accent" in this case is modern alchemy. Mostly, a partial redemption is the most we can count on, and this is usually of insufficient economical significance to be considered. The job must be done because an intelligent self-interest gives us the knowledge that to degrade any of our natural resources is to diminish our wealth as a people.

It is evident that an exploding population enjoying an increasing standard of living is going to require ever-greater quantities of water. I'm certain that more water can be put to use. Too much of it escapes during the heavy rains. However, the big change will be in the direction of repeated use. The water that serves in our homes, our cities, and our factories will have to continue to do so. In addition, this water will have to serve in the new homes, new cities, and new factories and still be suitable to provide recreation to a people with the high standards that go with affluence. To do this, it will be necessary that we apply all we now know, that we learn more and apply it, and that we manage removed contaminants in such manner that our water resources will be protected.

REFUSE INDUSTRY FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH

J. Vanderveld, Jr.

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He serves that organization well, and has also served on a number of public-service activities. He was a lecturer in a USPHS-sponsored solid-wastes training course in 1965, and presently serves the Governor of Illinois on a Committee on Refuse Disposal.

My talk will differ a little from what you have heard, in that we are going to get directly down to the grass-roots problem, taking a look at everyday problems in the management of solid wastes. As has been said, this is a growing problem. It is growing at such a rate that it is hard to keep it in a true perspective. Our experience would appear to substantiate some of the statistics that have been given by other speakers. My company, National Disposal, has been serving the northwest suburban area of Chicago for 29 years, and serving many municipalities in the state of Illinois and around the country. In the Chicago suburban area in the last three years

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alone we have had a 50% increase in refuse production per capita. One town in particular has had a 75% increase in the last three years. We have experienced similar increases around the country. So, as you can see from these figures, we have a mammoth operation to evaluate. The refuse industry plays a most significant part in it. So please bear these facts in mind while I outline some of the problems, along with some possible solutions which can reduce the expenditures involved and help overcome some of the problems.

We will examine three prime areas of difficulty: The first is people; this has been mentioned by a couple of other speakers also. When I refer to people, I am referring to the man on the truck, the man who is out on the front line actually handling the problem. With him, our primary concern is motivation and training. If we can motivate the man on the truck to have a true desire to be a productive worker and train him to do a proper job, one that will be a credit to the citizens he is serving, we are on the right track. At National, we place great emphasis on the individual, extending every effort to recognize and reward individual achievement, trying to build the person's self-esteem to the point where he will be happy with himself and consequently happy with his job. We provide the men with uniforms and training and fair-minded supervision, and this phrase also has been misused. We believe in advancement based strictly on merit. After all, outstanding performance deserves outstanding reward. This, too, has been misused. If the working man is aware of this, he will try harder. I also mentioned training. Training in the nonacademic sense is often talked about, but seldom put into effect. We can talk about the technology involved, we can talk about the intricacies of handling various waste materials, but the man who is on the front line needs training too. For example, in each of our divisions we conduct a continuing training program for new employees as well as present employees who have problems--which occasionally happens. Such a man is assigned to a training supervisor who conducts his training on a special route. This route is special because it has at least one of every variety of collection problem he is apt to encounter. This type of job training teaches the fundamentals of equipment operation, safety, proper working habits, attitudes, good public relations. In other words, how to say "good morning" within stopping his work, how to say it with a smile and keep right on walking. He is taught to handle the irritable customers--and we have a few of them too. But, in the process of this training, the employee's self-esteem improves and he is more desirous of being productive.

Also, supervisory personnel are encouraged to avail themselves of management training courses when they are available. However, one of the great difficulties we have faced has been the shortage of educational programs being offered today in solid-waste management. In addition to the employees directly involved in solid waste we have the people who are producing the solid waste, and those in authority who are responsible for proper management of it. We are all familiar with the attitude of the housewife who insists on a collection service on a regular schedule to get her problem out of sight. But try to place a disposal facility anywhere near that same housewife, and the problem immediately changes. It is not her problem; it is someone else's. Additionally, it is very difficult to get some of our elected officials to take a positive stand for solid-waste disposal programs. Apparently there is not much glamor in taking such a stand. These, then, are some of the problems with people.

I would like to make a recommendation or two. I would recommend that our schools of higher learning develop extension courses for the individual involved in solid-waste management at the supervisory level. There is great need for this, as well as for technical courses for staff personnel. As far as the general public is concerned, we need to direct more publicity and training toward them to show them that the waste they are creating must be disposed of and that they need to accept the most feasible and logical solutions that are available. The elected officials need to be more cognizant of the scope of the solid-waste program within the realm of their authority. This is something that needs to be faced continuously, not only as a last desperate measure. A firm stand is needed for what is right rather than what may be politically attractive or expedient.

It was not very long ago that the equipment used for refuse collection was the one-or-two-horsepowered wagon. Today we have giants, costing upward of $20,000 per collection vehicle, with 300 horses under the hood, automatic transmissions, automatic compaction devices, automatic equipment that will compact 50 and 60 yards of loose refuse into one body. We have made tremendous progress. The rate of compaction is such that, if we loaded them to capacity, some of these vehicles would be heavier than the present weight laws will permit. Obviously, what has happened is that the problem of capacity has been recognized. However, vehicle weight has not been given sufficient attention.

In the last few years a great deal of attention has been focused on containerization. We have portable containers of every type and description, sizes that vary from 1 cubic yard on up to 50 cubic yards, containers that can be located at the source of waste production, containers that have compaction devices attached or enclosed in the containers, containers to carry liquid waste, acids, chemicals, you name it. Much progress, but containerization brings problems too. For example, a $50,000,000 industrial plant was recently constructed in the Midwest with no provision for equipment to remove the waste material generated within the plant. After several meetings with representatives of the disposal firm, the management finally agreed to the necessity of erecting an additional building to house refuse disposal equipment. If our wastes are properly stored, we would simplify the management of that waste.

Basically, refuse is anything out of place. A new Stetson hat in the trash barrel is refuse because it is out of place. We use this example to point out how thousands of dollars are wasted every day. Valuable property is mistakenly placed alongside refuse to be collected. As a result, it is disposed of with the refuse. Another example: in a Barrington clothing store we serve, new suits and shirts which just had been received were stored with the refuse to be removed. No more suits or shirts! Or take the Rockford druggist who was missing $2,000 worth of new drugs. Investigation disclosed that the new drugs coming in were stored right next to the boxes of empty bottles and waste to go out. We need to emphasize that the wastes have to be separated, managed, properly stored, or the danger constantly exists that this valuable property will be collected and disposed of by mistake.

There are other problems related to proper storage that also increase the dollar cost to tax payers. I don't know if you realize it or not, but high-rising apartment buildings are often designed with no provision to get the refuse from the top floor down to the ground floor. Consider the dainty housewife on the 23rd floor carrying her garbage down the elevator to the lower level. One of our country's largest food producers completely overlooked the need for dock and storage facilities for waste material. As a consequence the employees carry the waste material out into the parking lot to the collection vehicles, resulting in an annual dollar loss to that company in the thousands of dollars, and this can be repeated around the country.

Such incidents point out the need to develop standards that will be helpful to architects, plant engineers, and anyone else involved in the planning of waste-producing buildings, to make them aware of the problems and to inform them of new solutions that are available. Quite often in the days of the two-horsepower wagon the solid-waste material was disposed of in open burning dumps that polluted the air and water, and offended the nostrils of anyone within miles. But, unfortunately, in many parts of our country today, very few inroads have been made on this type of irresponsibility. As we look at cities around the country, we find many that are still tolerating such conditions.

Our good friends in the Public Health Service have expended great effort in attempting to overcome these conditions, and much progress has been attained. However, there are still many that are in the horse-and-wagon stage. To overcome this, it is going to require the help of everyone in this room and everyone that we can talk to, to make them aware of the problems.

Industrial waste materials have been most difficult to dispose of. As was pointed out, this sometimes includes material that needs special handling, liquid, semiliquid materials, chemicals, plastics, toxic, highly volatile waste materials. Some require special handling, open transport, and disposal. And some of these require individual solutions. It has been true around the country that some of these disposal problems have been sidestepped by those in authority. The problem of household refuse is recognized because these are the voters and these are the people who are most vociferous. We need to recognize that commercial and industrial wastes require solutions as well as residential waste problems. After all, commerce and industry are the life blood of any community. A major need is for more cooperation between the refuse industry and other industries, and local government in finding disposal solutions. I believe that we need to establish minimum operating standards for refuse collection as well as minimum standards for its disposal for both public and private agencies. The state of Illinois, as mentioned, took a stand at its last legislative session that I believe is constructive. A refuse disposal advisory committee was appointed by Governor Kerner to advise the State Department of Public Health on waste disposal practices. This advisory committee has now established minimum rules and regulations for sanitary landfill operations in the state. These became law on April 1. Their next assignment is to require and to establish similar rules for other disposal methods such as incineration and composting, not to set up sites for the material. This committee is composed of two representatives of the refuse industry, two consulting engineers experienced in this field, and one city engineer. In the past the attitude of most people has been one of shifting the burden of responsibility onto others, rather than accepting the responsibility and resolving the problems. When the problems become critical or when the cost of a solution is being considered, only then can we generate interest from the public and those in responsible positions.

There has been much talk of planning on an area or regional basis. In the northwest suburbs of Chicago our firm has been providing a refuse collection and disposal service for 29 years, serving 16 municipalities, each with a service designed according to the wishes and needs of each community. We are providing a central landfill for all of the waste material. Each community's problems are handled individually and the problems successfully blended into one collection and disposal solution. Industry has made significant contributions to the solution of some of these problems that I have mentioned, though much more needs to be accomplished. Through our sister company, Metropolitan Waste Conversion Corporation, we have been conducting research and development work in composting processes for several years. We have been working successfully with many of the different waste materials emanating from agriculture, stockyards, canneries, sewage, household refuse, and industrial refuse. We've been operating continuously for a year and a half now, with a plant capacity of 50 tons per day. In addition, we've developed a market for the finished product to such an extent that, right now, we have a backlog of orders for over 1000 tons of compost. The material being developed is such that it is in great demand by golf courses and by people in the field of agriculture. It is selling, by the way, at $16 a ton.

The waste materials which we have been discussing are the cast-off portions of the natural resources of our country. I'd like to leave you with one example. A Washington chemist recently spoke of reclaimed sauerkraut juice, which at one time had been dumped down the sewer. It is now being canned and sold at pharmaceutical houses as an ulcer cure. So, as Mr. Brown illustrated in some of his cartoons yesterday, we can now connect the cure for ulcers with the cause of many ulcers--waste management!

GOVERNMENT FACETS OF THE SOLID-WASTES PROBLEM THAT MUST BE INTEGRATED INTO A MANAGEMENT-SCIENCE APPROACH

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My assignment is to cover the place of government among the elements that must be integrated in a management-science approach to the solid-wastes problem.

All of us will agree, I am confident, that the solid-waste management role is pivotal.

Government must bring together the specialists needed to solve the wastes problem--the legal experts, the planners, the leaders of businesses and agriculture unavoidably involved in waste production, members of the refuse industry with know-how in advanced disposal technology, waste management engineers, vector-control specialists, sanitarians, and public-information specialists.

Responsibility for needed waste-disposal coordination can logically be accepted only by government. So we must start with the assumption that government will be at the operating center of solid-wastes management, that it will program the input of all factors involved, and that it will initiate the formation of what we may call the solid-wastes management team.

But it seems to me that before government can go very far in stimulating waste management integration, all levels of government must identify the responsibilities that are theirs alone and the responsibilities that they share with others. Much of my talk is concerned with identifying individual and shared responsibilities, as I see them.

Solid-wastes management, like air and water pollution control, calls for a degree of intergovernmental cooperation seldom achieved in public affairs. Efforts to solve the wastes problem, moreover, thus far have almost totally lacked widespread support from an informed and interested public, an element without which no government program can long succeed.

Almost everyone knows and is concerned about air and water contamination and is willing to support efforts to minimize it. But few Americans yet know or care very much about how we are to dispose of a rising load of solid wastes now approaching 200 million tons a year without incurring serious human health hazards and disfiguring cities, towns, suburbs, and countryside.

Except for people who must walk through littered alleys or live near fly-and-rat-infested dumps, or endure the stench of overloaded incinerators, members of the general population are rarely conscious of the broader aspects of the solid wastes problem. No major threat to environmental health in this country has been so widely ignored.

Public apathy, which had much to do with generating the solid waste problem, remains a basic impediment to its solution. To alert the American people to the fact that they have a problem which is rapidly approaching a crisis--and to gain their support for corrective action--is a waste management responsibility facing all levels of government. This responsibility adds enough to the complexities of integrating safe and efficient waste disposal practices throughout the United States to severely test government agencies' ability to work together as a team.

Federal participation in local and state efforts to solve ever-worsening waste management problems is now authorized by law. Moreover, acting under authority of the Solid Waste Disposal Act, the Public Health Service's Office of Solid Wastes is now undertaking a program to make the federal government an active full-time management partner of local and state agencies.

The Waste Disposal Act recognizes that primary responsibility for waste management rests with communities and states. But the Act also fully recognizes the fact that if this nation is ever to have a balanced wastes program, responsibility for its development, if not its direct execution, must be shared at all governmental levels. The central purpose of the Act is to make federal resources available for a coordinated team attack on the solid-wastes problem on a national basis.

As envisioned by the Act, the national solid-wastes program will support local and state waste management operations in five major areas.

First, the program will provide for conduct and support for research and training in solid-waste technology. Of primary interest, as you might expect, will be investigations related to the health aspects of wastes management, including studies of the biological, chemical, and physical characteristics of solid wastes which may be associated with environmental contamination problems.

Other research efforts may be aimed at the development, on a laboratory scale, of new methods for more sanitary and efficient waste collection and disposal. Still other research projects, to cite other examples, might investigate improved techniques for reuse and salvage of materials and energy that would otherwise be lost if waste disposal practices continue as at present.

Training grants will be made to universities to establish or expand graduate instruction in solid-waste management and control. In addition, the Office of Solid Wastes will design and conduct an extensive in-service training program of its own to strengthen the professional staffs of responsible governmental agencies in solid-waste technology.

In the second major support area, the national program will provide grant assistance to demonstrate the practicality, on the scale of field operations, of improved methods for solid-waste collection, storage, processing, and disposal. Such demonstrations may be concerned with any or all elements of a comprehensive system of solid-waste management, including its capability for eliminating environmental contamination, the safety of new equipment, and its economic feasibility.

As its third primary responsibility, the national program will support studies and investigations by community, state, and other agencies other than federal. These inquiries are to be of a type which might lead to a demonstratio of improved practices or provide solutions for regional or national solid-waste management problems. Studies and investigations of whatever character must be coordinated with state or interstate solid-waste management plans, where they exist, as a condition of federal support.

In the fourth area of federal support, grants are to be made to help pay for surveys and planning to develop waste management systems by agencies with sole responsibility for introducing such systems on a statewide or interstate basis.

Technical assistance to local and state governments will comprise a fifth major category of federal activity. Here, the Office of Solid Wastes will assist with specific difficulties that arise, for example, when determining standards for community disposal practices. We need to manage solid wastes for everybody, not just for those who create them.

The Solid Waste Disposal Act, it may be pointed out, specifically requires the federal government to encourage planning for and the conduct of "interstate, interlocal, and regional solid waste disposal." It should also be observed, incidentally, that more than four-fifths of the states have yet to authorize the establishment of disposal districts, which merge the waste management needs of several communities and may even cross state lines. And until such districts can be established wherever needed, it seems fair to say that waste management in the United States will remain probably the most backward of all environment-improvement technologies.

The significance of the Solid Waste Act and the establishment of the Office of Solid Wastes is quite clear. It is that, for the first time in this country, we can organize a solid-waste management team at all levels of government to attack the problem with the help of industry and the support of the public. But before passing along to consideration of what roles, in my view, the various team members ought to play, on an individual or shared basis, there is an administrative development that should be noted.

A few days ago, as some of you may know, regulations under which the Office of Solid Wastes will administer the study, investigation, demonstration, and state survey and planning grant aspects of its program were published in the Federal Register (Vol. 31, No. 61, pp. 5100-5103--March 30, 1966). Six provisions of the regulations may be of particular interest:

1. Ensure equitable distribution of demonstration awards among the states by stipulating that no one state should receive more than 12½ percent of the total appropriation for this kind of grant.
2. Make possible federal support of two-thirds of the costs of demonstration and investigation grants and up to half the costs of survey and planning grants.
3. Make only public or nonprofit private agencies or institutions eligible for grant awards.
4. Require states receiving planning grants to have full-time solid-waste planning directors.
5. Provide for review of demonstration and investigation of grant applications three times a year, a schedule which will make it necessary for applicants to allow six months between application submissions and anticipated project starting dates.
6. Provide for review of planning grants once a year, with all applications after this year to be submitted by September 1.

There is scarcely an aspect of solid-waste management which does not involve more than one level of government. On the other hand, the function is most intimately associated with the smallest units of government, i.e., municipalities, towns, and villages, making it particularly difficult to organize regional operations. While local, state, and regional government agencies, for example, must always have direct responsibility for collecting and disposing of wastes, the federal government has had to assume the task of supporting research, demonstration, and investigations for waste collection and disposal improvement, if only because this type of work is clearly beyond the reach of local and state governments to organize and to support financially.

In truth, communities and states in many instances have been unable even to take the financial risks involved in investing in new but not yet wholly proven solid-waste technology. The only feasible approach for most municipal and county governments has been to invest in established techniques. Mainly for this reason, there was little prospect--until the federal government joined the waste management team--of even closing the gap between field practice and the limited waste-engineering knowledge which research has developed in the last few decades.

Research is needed just to make a start at the development of improved waste disposal technology. An example is the lack of precise and current data on the chemical composition of solid wastes. Such data, coupled with information about the wastes' physical characteristics, are essential in developing sound incineration practices and equipment to employ recent advances in combustion theory, and the use of high-temperature materials not yet generally incorporated in large municipal incinerators.

The federal government will be able to generate little progress along such research lines as these without local and state assistance. It isn't enough, for instance, to develop new information about the chemical and physical characteristics of solid wastes without obtaining a large amount of related data, available only at nonfederal levels. Such data would include information on the ranges of composition of waste mixes and their geographic and seasonal variations.

As most members of this audience know, but as the country as a whole is only beginning to realize, solutions to the solid-waste problem, like those of air and water pollution, cannot be compartmentalized within political subdivisions or geographical boundaries. The common tendency to "Balkanize" the development of disposal practices has been a major deterrent to waste management progress.

Some pretty horrible examples of what might be termed waste management isolationism can be cited from all sections of the country.

A county in one of our eastern industrial states, for instance, was permitting wastes to be handled separately in 129 political subdivisions. In the San Francisco Bay Area alone, 83 agencies in the nine Bay Area counties were seeking to dispose of wastes in someone else's backyard, as it were, at 77 separate sites. On the other hand, at least two counties (Los Angeles and Orange) in this state have provided the nation with outstanding examples of waste management in systems which integrate collection and disposal for scores of municipalities and large unincorporated areas.

Let me be quite clear at this point that what we are urging here is consideration of mechanisms for more efficient waste management, not the establishment of metropolitan government. In one area, a suitable mechanism might be a county agency. In another part of the country, it might be more appropriate to make waste disposal the responsibility of an intergovernmental body. Or the function might be discharged by one of a number of political subdivisions on a reimbursable basis. Whatever the mechanism, the sole objective is more sensible waste management to prevent a continuing contamination of the environment.

The recently published National Academy of Sciences report on Waste Management and Control proposes the development of disposal systems on the basis of "problem sheds." These are areas which share interrelated problems of air, water, and land pollution of such magnitude as to justify and require an integrated approach. The "disposal-site" problem alone in solid wastes is becoming so severe in many areas that regional or "problem-shed" solutions are unavoidable. Regions incorporating a number of sources of wastes and suitable disposal sites might be considered solid-waste "problem sheds."

The first need in establishing waste management districts, or "problem sheds," obviously, is for states which have not already done so, to authorize cities, counties, and other political subdivisions to set up and operate regional waste disposal systems. In some cases, states would have to act jointly to permit systems to function across state lines. Legislation authorizing the creation of solid-waste districts has not been adopted in more than nine states.

Much of what is wrong with solid-waste management in the United States can be attributed to the practice of fragmenting responsibility among small political jurisdictions which, almost without exception, lack sufficient resources for the job. It is often for this reason that incinerators have been operated long after they have become hopelessly overloaded and obsolete, forcing the reinstitution of open dumping and open burning.

Small-community authorities have usually found it next to impossible to effect the economies in waste collection inherent in larger systems. Yet, collection represents between 75 and 90 percent of the cost of disposal and therefore affords the greatest opportunity for savings.

It seems certain that a very high priority ought to be given local, state, and federal team efforts to establish well-planned solid-waste disposal districts wherever needed to end the multiplication of health hazards, urban and rural blight, and other consequences of waste-management chaos in the United States.

Opportunities for intergovernmental cooperation exist, it seems to me, even in the enactment and enforcement of local ordinances prohibiting open dumping and open burning. Without involving itself in the exercise of police power, a federal agency might well assist local governments in drafting ordinances and codes embodying proven procedures and workable standards.

Carefully drawn and strictly enforced local prohibitions against open dumping and open burning would markedly reduce present sources of rodent-

and insect-borne disease and air pollution and correspondingly moderate one of the most troublesome phases of the solid-wastes problem. Many burning dumps, I am confident, could quickly be converted to sanitary landfills for no more than the cost of training personnel and acquiring a relatively small amount of equipment, most of it of the multipurpose earth-moving variety.

The present trend toward extensive urban rebuilding and the development of entirely new towns is creating ideal conditions, it seems to me, for intergovernmental teams to make real progress in improving waste technology. In many cases, it would be possible to incorporate, with federal support, newly developed equipment and methods, possibly evolved from federally financed research, as integral parts of urban renewal or new town projects. This could be done at the planning stage to avoid design modifications during project construction and to keep installation costs at minimum levels. Advantage could be taken of general public interest in city redevelopment and new towns to illustrate to the nation how wastes can be best handled through new technology. Here, obviously, the local, state, and federal team would have a new member--the private builder.

All governmental agencies concerned with waste management--and business and industrial organizations, as well--share an obligation, in my opinion, to encourage imaginative thinking about the problem. We need qualified people thinking constructively, for instance, about the feasibility of the perfect incinerator--no smoke, no noxious gases, no pollutants. Or about piping "systems" for transporting refuse over long distances. Or whether we should distribute useful organic wastes on sterile desert land and build mountains or fill caves with scrap iron which might later be mined easily.

And shouldn't we be thinking a lot more positively about salvage technology? Or about the design of products so that the principal materials of which they are made can be sent back for reuse in manufacturing new products?

With many problems, it will be necessary to have strong help from industry. I believe that industry should be encouraged to devote a portion of its research and development resources to waste problems other than its own. The federal government, through the Department of Commerce and other agencies, is often in a position to provide such encouragement.

But all levels of government have opportunities to influence waste-management improvement through procurement, by drawing up product performance specifications to reduce waste, or by requiring the incorporation of modern disposal systems in designs for schools, office buildings, hospitals, military installations, and other facilities.

Government agencies themselves are large producers of solid wastes and should be exemplary in their disposal methods.

An area in which all governments can and, I believe, must collaborate is in establishing realistic goals for solving solid-wastes problems. We should be able to agree, for instance, to use improved techniques for an early target date to achieve a 50 percent reduction in solid waste contamination of the environment. Another goal would be to eliminate open dumping and open burning throughout metropolitan areas of the nation at an early date. Still another goal would be to have interagency solid-waste disposal districts authorized by all states within, say, the next five years.

Attainment of such goals would be dependent, among other factors, upon wise allocation of federal money among feasible research, demonstration, and planning projects, and for support of university courses in solid-wastes engineering. Experts at all levels of government will have to participate in making such judgments as these.

In judging the capabilities of the federal government as a member of the solid-wastes team, we should be realistic. One difficulty is that although available resources are substantial they are also finite. They represent, furthermore, only a fraction of the backlog of waste management needs in this country. Realistically, the federal role ought to be regarded as providing resources for an important initial step on the road toward national solution of the solid-wastes problem.

Those of us who would improve waste management in this country have a responsibility to which allusion has already been made but about which there is sufficient urgency to warrant re-emphasis. I refer to our responsibility to work as effectively as we can to overcome the public apathy which has been such a characteristic factor in the solid-waste problem. We must overcome the public's idea that the perfect disposal system costs nothing to build and nothing to operate.

Local and state as well as federal funds must be spent on new solid-waste disposal facilities and procedures. This may mean raising state or local taxes or voting new bond issues. Certainly it is incumbent upon local, state, and federal governments to see to the conduct of the kind of information programs that will make people throughout the country aware of investment needs for solid-waste management and evoke the essential willingness to pay for them. Without this kind of effort, there can be no prospect that this nation will handle its solid wastes in a manner commensurate with its aspirations for a quality environment.

In view of what you have already heard at this conference, there is no need for me to dwell upon how much we will require the application of principles of management science in achieving an integrated, balanced national program of solid-waste disposal. The multiplicity of the decisions we shall have to make and the variables we must consider in making them are awesome.

From the assignment of refuse collection routes in our cities to the allocation of resources for research, we shall have to make the best possible application of scientific management know-how. It can literally be said, I think, that had not data processing and computer technologies been developed, we should have had to develop them before we could hope to conclude the task before us.

But there are things that computers and scientific management cannot give us. The chief of them for our purposes, I believe, is that human quality which makes men willing to work together for a common cause. We can call it dedication or cooperativeness. We can call it team spirit. Whatever we call it, we shall need it in abundance.

ONE COMMUNITY'S SUCCESS

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Mr. Cheek is a member, and has actively served, in a number of professional technical societies. Two are of note: the American Public Works Association, in which he is a past state president; and the National Society of Professional Engineers, where he has served as national director and state vice-president.

In the last week, Detroit newspapers carried many pictures and stories about space ships. These are authentic--no question about it--because some people took pictures of the ships, and they were published on the front pages of the papers. In Washtenaw County, where most of these were seen, six deputy sheriffs in six different scout cars saw these. The sheriffs converged on the site where the ships were reported. People saw the ships from their homes, went outside, looked at them, and later described their sizes and colors. All of this was at night, but the next day, when it became light, they did find depressions in the swamp grass where at least one ship had landed. So the U. S. Air Force decided they would call in one of their experts, Dr. Heyn, from Northwestern University, to make an investigation. As usual, he said that it was just swamp gas that the people saw, that they were all mistaken. I then decided to make a little analysis of it myself. What I am saying here--I want you to understand--is not anything that would be confirmed by the Planning Commission. I'm speaking on my own. After doing a little systems analysis, I came up with this: I found that the people from Mars have a culture much much older than we have, and so they have had a longer time to learn all the techniques of space travel and are way ahead of us. They have had problems up around Mars for a long time, and one of their problems is the same problem we've had here: they have to get rid of their refuse. So they've been carrying it over to our moon and putting it in the craters all these years. But they filled the craters up and had to go someplace else. So, what was happening a couple of weeks ago? They had sent scouting parties down here on Earth to look for some more landfill sites.

Now that just proves this conference should have been held many many years ago.

Five years ago the Detroit Metropolitan Area Regional Planning Commission, which at that time was the regional planning agency for five southeastern Michigan counties, decided to place more emphasis on facility planning. That decision was reached after a Joint Policy Study by a Committee of Supervisors appointed by the chairmen of the five county boards. The persistent and critical problems of refuse disposal were high on the list of priorities. The Supervisors Inter-County Committee, an intergovernmental forum for policymaking, from the six southeastern Michigan counties (this agency covers six counties rather than five counties) requested the Planning Commission to make a study and offered to take a major role in implementing recommendations which would develop from the study and plans for a regionwide refuse disposal system.

A definite part of the planning, from its inception, was the inclusion of future use of final land disposal sites for local, county, and regional recreation facilities as a part of the regional comprehensive planning. Another salient feature was the requirement that there be alternate plans for consideration. The study was designed to include collection practices, but only to the extent that they would influence disposal of the refuse.

An advisory committee, selected from top-level people in planning commissions, health departments, public works departments, county road commissions, universities, and private consultants in the sanitation field, was chosen to participate in the study and planning. (You may note that I link these words study and plans frequently because this was not to be a dust-gathering study!) Early in 1962 your speaker was selected director of the project. Two subcommittees were chosen from the advisor group to develop: 1) a questionnaire; and 2) a set of standards for proposed sanitary landfills and residential, commercial, and industrial incinerators. These standards are included as a part of the report.

A 13-page questionnaire was mailed to all of the 178 cities, villages, and townships in a 3,250-square-mile 5-county region. An indication of the widespread interest in this project and need for the study and plan is the fact that 111 of the 178 cities returned their questionnaires within 30 days. Many previous local studies had been prepared by, and for, various governmental agencies in the region; studies and reports from other localities in the United States were collected and analyzed.

Questionnaires were followed by staff interviews with local public officials and private sanitation contractors, and field studies were made of methods and operations used for collection and disposal in the region. Study was also made of disposal methods in areas outside the Detroit Region.

In analyzing the questionnaires we learned that, of the 178 municipalities, 62 disposed of part or all of their collected refuse in areas outside their own boundaries. In other words, they were following the Scriptural injunction: "It is more blessed to give than to receive." Another significant fact was the statement by 66 of the communities that they favored a consolidated program of some kind. They didn't want to go it alone.

Early in the study it became obvious that any one method for disposal was not practical. Some of the main factors in determination of disposal plans were density of population, now and in the future; advisability of several different methods of transporting the refuse to ultimate disposal sites; and topography and shape of the urban area. The five-county region was divided in two basic areas: the central core area (including Wayne County, most of Oakland County, and about one-half of Macomb County); and an outer area. It is anticipated that the boundaries of these two basic areas will change little, even up to the year 1980, which is the period covered by the proposed plans. Why did we pick 1980? One reason was that we didn't have population projections beyond that time, and it was about 18 years away.

After a study had been made of the various methods of disposal which might be available, the conclusion was reached that only two basic tested methods were feasible for collected refuse in the Detroit region. I'd like to repeat that. The conclusion was reached that only two basic tested methods were feasible for collected refuse in the Detroit region: 1) incineration in large-scale publicly-owned-and-operated incinerators, with disposal of residue in sanitary landfills; and 2) sanitary landfilling of the raw refuse.

Two basic plans were developed. The first one, designated Plan I, would utilize the presently operated four large City of Detroit incinerators plus three smaller ones in the region. Service districts would be so arranged that efficiency would prevail and political boundaries would be ignored. The balance of the collected refuse in the central core area which could not be processed in the existing incinerators would be hauled to transfer stations, loaded into large packer units, and, along with the incinerator residue, transferred, "piggy-back" by rail, to a large, long-range landfill site. The daily special trains would operate on regular schedules from the central core area to the landfill site. This part of the planning of the transport is a part of a comprehensive planning for the area in which one aim was to get trucks off the roads so that, once you hauled the material to a transfer station, there would be no trucks or any equipment going over the roads from that point on. They would go right to a landfill site by rail, which means quite a bit in the transport of a region.

After the basic data were collected, and two alternate plans for disposal formulated, a firm of consulting engineers was engaged to develop basic cost data and financing proposals. A landscape architectural firm was employed to prepare treatment sketches for reuse of the completed sanitary landfills. Because, after all, you have to end up with a sanitary landfill, no matter what kind of a method you use.

In Plans I and II, in the outer area, districts would be designated around 45 sanitary landfills. In other words, everybody in the entire five counties was provided for. All of the refuse from these districts would be disposed of at the publicly-owned-and-operated sites. Another feature we recommended was that all sites be publicly-owned and publicly-operated. An exception to Plan I was exclusion of one small city that had a combination incinerator constructed recently, and two sanitary authorities which operate one incinerator each and are serving 19 member communities in the central core area.

In Plan II, seven new incinerators would be constructed in the central core area, making a total of 14. All combined collected refuse would be processed in the 14 incinerators, and the residue would be hauled, "piggy-back," to the long-range landfill site.

Now back to Plan I again, it was estimated that 1,830,000 tons per year would be disposed of at the major landfill site in the year 1980. This would include incinerator residue and the raw refuse. And in Plan II, the plan which would incorporate 14 incinerators, 464,000 tons would be buried at the same site in the same year, 1980. The study proposed that one regional agency be created to plan, finance, construct, and operate the facilities of the central core area.

The report was published in January of 1964, and as soon as it was off the press a full-dress presentation was made to the Supervisors Inter-County Committee at its regular monthly meeting. The Inter-County Committee recommended that each County Board of Supervisors appoint a subcommittee from its membership to study the report and plans and to submit its recommendations to the respective County Boards of Supervisors, which in turn would report back to the Inter-County Committee. Those committees were appointed.

One deterrent to early action by those study committees was the imminent possibility of the passage of the County Home-Rule legislation by the state legislature. We're still looking for the home-rule legislation. There were some opinions that possible county charters might permit more desirable alternates to the disposal plan, particularly on the method of setting up governmental agencies or cooperatives, contracts, or whatever you might have. Two of the five counties were in the midst of studies looking to establishment of a County Department of Public Works, which could be an agency designated to operate a county-wide system for refuse disposal.

The first county to take formal action was Monroe County, which is entirely outside the central core area. In other words, it would be served strictly by landfills. The supervisors formally approved the plan, as it applied to their county, and so notified the Supervisors Inter-County Committee. Washtenaw County, a county to the west of Detroit, has reported that it does not wish to participate in the plan at this time. However, some of the recommendations in the report have already been implemented in that county, on a district, not a county-wide, basis. The three counties involved in the central core area--Macomb, Oakland, and Wayne--have taken various actions to date. Macomb County has voted to defer any action on the regional plan until the Board of Supervisors has received a report from the South Macomb Disposal Authority. That authority is an agency consisting of five cities in the southern part of the county. The Authority has proposed to acquire and operate sanitary landfills throughout the entire county. It would change its name to Macomb Disposal Authority and expand its membership to include the rest of the county. The report from this authority is due 30 to 60 days after February 14, 1966, so it is due in a couple of more weeks. The Wayne County Supervisors have designated the Road Commission as the agency to finance, construct, and operate up to five new incinerators in Wayne County. A contract for engineering feasibility studies has been signed, and they have four months to produce a feasibility study. At that time the County Road Commission will present costs, locations, and operations to the communities within Wayne County and possibly some parts of Oakland County, and ask for contracts. The Road Commission has also proposed to acquire and operate the seven existing incinerators listed in the study plan. The Road Commission has already gone on record as not desiring to operate the system in the future if other communities wish to set up an area-wide system. They will relinquish their exclusive control over the county operations in Wayne County, but, whatever they do or wherever they build their facilities, they are to fit into the regional plan. The Oakland County Study Committee, the third county in the central core area, has prepared recommendations for board action. They have not been made public yet. They will be made public and the recommendations will go to the Board of Supervisors and be acted upon during this month. The Supervisors Inter-County Committee has been conducting a series of special meetings which has included the Chairmen of the County Boards, technicians from each county, the Regional Plan representatives, and representatives of the Metropolitan Fund, Inc. The purpose of the meetings is to speed implementation of the plans.

I am now quoting: "The Metropolitan Fund, Inc., is an urban affairs foundation conceived to develop research and action on metropolitan problems in southeastern Michigan." In other words, this is a nonprofit privately financed organization which is interested in promoting such projects as we are talking about here. Its trustees are top-level people in various fields of endeavor. When I say "top-level people," I mean the four major university presidents in Michigan, the presidents of the four major automobile companies, presidents of the largest banks, the president of the largest mercantile establishment in Detroit, and on down the line to the mayors of the largest cities in each of the five counties. These people, the president of the UAW, and so on, are of course well-known throughout this country, and some of them are known internationally. The Metropolitan Fund has taken a keen interest in the regional problem of refuse disposal, and underwrote the cost of constructing the models you see over there on display. These models have been displayed throughout our region in city and county buildings, bank buildings, at conventions, etc., during the last 2 years. The Fund also financed the cost of printing brochures, which have been widely distributed, and I might say that when the brochures were printed, one of the utility companies did all the art work on them, free of charge. We tried to get everybody involved in this project. At present a municipal consultant, retained by the Metropolitan Fund, is preparing a detailed report on a possible governmental organization structure to implement the plan. It is expected that the report will be published this month. The Fund has also gone on record with the statement that it stands ready to help implement the plan when the final decisions are made, and in helping to implement it they will furnish television time, radio time, newspaper advertising, or whatever else may be necessary.

During the 1965 session of the Michigan Legislature a law was enacted which provided for licensing and control of all refuse disposal operations in the state. The licenses are issued by the State Health Commissioner. Many of the regulations adopted for the design and operation of sanitary landfills were extracted, word for word, from the standards published in the refuse report. The effect of the regulations will be to eliminate all open dumps, except minor operations located more than two miles from human habitation or places where humans congregate. Even those dumps must have written permission from the state health commissioner to operate, and must not be a source of nuisance.

Every problem creates other problems. A professor of psychology, lecturing his class one day, said, "The best way to quiet a hysterical girl is to kiss her." And a strapping young fellow in the back of the class asked, "But professor, how do you get her hysterical?" This paper would not be complete if I did not make some recommendations as to what we would do if we were to do the planning again. The most important thing we failed to do was to include in our planning process a definite program for implementation.

In other words, if plans gather dust, they are no good. The agency to which our report was directed, the S.I.C.C., has no legal implementing authority. Financing of the study and plan should have included staff time of the Planning Commission to assist in implementation. Local units of government below the county level should have been more involved in the implementation planning. Civic organizations, such as the League of Women Voters, should have been courted for their help. Definite legislation at the state level, the need for which is now apparent, should have been prepared for review by the local governments.

Although the apparent trend at present is not to follow the Planning Commission's proposed inclusion of a central agency in the early stages of implementation, most of the steps taken, so far, will make it possible to fit the programs into a regional plan. An interim step will probably be countywide operation of facilities with some inter-county contracts. The full impact of the new state law governing disposal sites has not yet been felt. A proposal to establish a new Council of Governments is now under study by a blue-ribbon committee of [illegible]. This council would expand the scope of the S.I.C.C. and include over 400 local units of government in the six-county region. And, finally, the Department of Housing and Urban Development "money-tree" may play a role in nudging decision-makers to final logical conclusions as to the best way to operate the facilities.

LOS ANGELES COUNTY ACTIVITIES IN REFUSE DISPOSAL

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Mr. Bowerman hardly has time for his work; he is so much in demand for public-service activities.

He is a registered civil engineer, and an active member of many professional societies. In 1962 he was co-recipient of the American Society of Civil Engineers Rudolph Hering Award. In 1965 he received the Charles Walter Nichols Award from the American Public Works Association. He also serves the Public Works Association as Vice President of its Institute of Solid Wastes.

The County Sanitation District law of California is codified as Chapter 3, Division 5, Part 3, of the State Health and Safety Code. This legislation permits a county board of supervisors, on its own initiative, to organize a sanitation district. Until 1947 the sole function of a sanitation district was to build trunk sewers and appurtenant works designed to collect sewage and industrial wastes, by intercepting the flow of local or lateral sewers, and to effect its final disposal. In 1947, at the instigation of the County Sanitation Districts of Los Angeles County, the act was amended to permit a sanitation district to engage also in refuse collection and disposal.

Immediately after a district is formed by a county board of supervisors, its governing body becomes a board of directors made up of the presiding officer of the city council of each city, in whole or in part included in the district, and the chairman of the county board of supervisors, the latter representing an unincorporated area in the district.

In Los Angeles County the operating sanitation districts include, in whole or in part, 70 of the county's 76 incorporated cities, and large tracts of unincorporated area. Each city is represented on every board of directors of each district that includes that city, in whole or in part. Thus, for example, the City of Long Beach is represented on the Boards of Directors of Districts 1, 2, 3, 8, and 19, while the City of Sierra Madre, lying wholly within District 15, is represented only on that Board.

A sanitation district may contain either incorporated or unincorporated territory, or both. So far as sewage is concerned, the district is formed not so much with reference to existing political boundaries as to topographic features, because, for this purpose, the function of the district is drainage, and it therefore usually takes the form that will best admit of a natural downhill drainage system. This may conflict to some degree with refuse disposal, but has not yet seriously done so.

After being legally formed by the board of supervisors, the district, through its directors, has definite powers, among which are the following:

a) It may employ engineering and management personnel.

b) It may own property and construct and operate collection and treatment works for the disposal of sanitary sewage, industrial waste, and refuse.

c) It may own and operate its works jointly with other governmental agencies.

d) It may sell valuable by-products of its operation.

e) It may issue bonds.

f) It may cause taxes for district expenses to be levied.

g) It may do the work of construction with its own forces or by contract.

While the foregoing are not all of the district powers, they are representative and clearly indicate that the legislation is designed to permit districts to construct and operate, either alone or jointly with other districts, facilities to intercept the flow of sewage and industrial waste from local collecting systems, and to dispose of it; or to finance and operate refuse collection facilities designed to dispose of refuse from the district area.

The refuse disposal system of the county sanitation districts is a coordinated disposal system with economic, public health, land reclamation, water and air pollution, transport, flood control, local environment, and ultimate land use considerations foremost in its development.

In October 1950, and again in September 1955, the Chief Engineer, by board order, submitted reports to the Boards of Directors of the County Sanitation Districts, outlining the status of refuse collection and disposal in Los Angeles County. A result of the 1950 report was establishment of a refuse disposal fund by a modest tax levy in 13 districts of 2 cents per $100 assessed valuation for a five-year period and 1 cent per year for the following five years. The 1955 report, after evaluating various disposal means, recommended that the districts actively pursue the acquisition and implementation of refuse disposal landfill sites and transfer stations as a means of serving the public in the field of refuse disposal as necessitated by the then pending county ban on household backyard incinerators.

Since that time, the districts have opened five landfill sites to the public, and one transfer station, in the following order:

May 1957	Palos Verdes Landfill
July 1957	Spadra Landfill
January 1958	South Gate Transfer Station
June 1960	Mission Canyon Landfill
February 1961	Calabasas Landfill
March 1961	Scholl Canyon Landfill

The cost of acquisition and implementation of the above facilities was greater than the funds accumulated through the districts' special tax levy. To accomplish the planned system, the districts entered into Joint Powers Agreements for operation of the five landfill sites with the County of Los Angeles and, in the case of Scholl Canyon Landfill, with a third power, the City of Glendale. For an amount equal to 40% of the land purchase price, the County of Los Angeles bought the fee title to the Palos Verdes Landfill site. The balance of the purchase price, as well as the implementation costs, came from the sanitation districts' tax fund. Acreage comprising the Spadra Landfill was purchased in fee by the county, and the sanitation districts assumed the responsibility of repaying the county costs at no interest over the life of the landfill operation and also provided the implementation costs. The South Gate Transfer Station was financed entirely by sanitation district funds. Mission Canyon and Calabasas Landfills were established by the county's purchasing of the land, and "start-up" funds were advanced. The districts make the county annual payments which will completely repay all county costs at no interest by the time the landfill capacity is depleted. Fee title to the land will rest with the county. The canyon that contains Scholl Canyon Landfill is owned by the City of Glendale. The county acquired additional land, constructed an access road to the canyon site, and provided "start-up" funds for the operation. The sanitation districts pay the City of Glendale and the County of Los Angeles each 25 cents per ton of refuse deposited in the landfill.

The districts do not collect refuse, but maintain the disposal sites and transfer station, open to the general public and the municipal refuse collection agencies. Each load is weighed on large truck scales, and the customer is assessed a "per ton" charge, based on the total costs that the districts incur in disposing of his material. To facilitate rapid processing of weight and charge determinations at the landfill entrance, tare weights are established for each regular customer's vehicles to eliminate repeat weighing of empty vehicles. By posting a bond or cash deposit equal to an anticipated month's charges, a regular customer can be issued a credit card for each of his vehicles with the vehicle tare weight imprinted on it. The weighmaster then accepts the card from the driver, weighs the loaded vehicle, makes the weight and charge extension on a printed receipt, and returns the credit card and a copy of the receipt to the driver, and the customer is billed at the end of the month. Municipal agencies are exempt from the bond requirement. This quick weighing procedure allows the weighmasters to process approximately 60 vehicles per hour per truck scale.

Each truck load of refuse is spread and compacted into the refuse fill with a bulldozer, D-8 size, and at the end of each day the exposed refuse is completely covered with soil. This procedure has resulted in no internal fires, no rodent harborage, no fly propagation, and maximum eye appeal during the construction phase. The swarms of seagulls present at many landfill sites are unknown at the districts' landfills because, if the refuse is not being "walked" on by a crawler tractor, it is covered by soil.

As the terrain changes within the operational area, provision is made for temporary diversion of storm-water flow during the rainy season. A water supply for domestic use, dust control, and fire prevention is maintained at each of the disposal operations by means of pumping stations and strategically located reservoirs and pipe lines. Temporary side slopes are grass-seeded for erosion control, and interim plantings of shrubs and trees are made to improve the appearance of the operation until final development of the upper surfaces is completed.

Each of the five landfills now in operation is scheduled for development as a city or county park, golf course, arboretum, etc., and, as areas of the landfills near completion, refuse and soil cover are placed to form the contours necessary to fit the park plans. At the time of this writing, a parcel of 82 acres at the Palos Verdes Landfill has been released to the Los Angeles County Department of Arboreta and Botanic Gardens for development as the South Coast Botanic Garden.

The South Gate Transfer Station is a direct-dump type of operation that allows the station customers to drive onto an elevated platform and discharge their refuse over the edge directly into a waiting transfer trailer parked parallel along the reinforced concrete retaining wall that defines the upper dumping platform. Eight trailers park along the wall and are hauled in sets of doubles to the more distant landfills. A set of two 25-foot-long trailers can carry a payload of approximately 22 tons of refuse.

Slightly more than seven years ago, this disposal system was nonexistent. Today it handles approximately one-half of the total refuse generated in the Los Angeles Metropolitan area. Its present effectiveness is demonstrated by the fact that six cities within the Los Angeles area have closed down their municipal incinerators in favor of it. Prior to the opening of Palos Verdes Landfill, in 1957, the Regional Planning Commission public hearing for consideration of the landfill operation was attended by a great number of citizens bitterly opposed to establishment of the first landfill operation. Seven and one-half years later, a Los Angeles City Planning Commission public hearing regarding a conditional use request for an extension of the Mission Canyon Landfill into a neighboring canyon was not attended by a single person opposing the request.

SOLID-WASTES RESEARCH USING MANAGEMENT SCIENCE

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Mr. Swager originally trained as a chemical engineer, but has moved into economic, marketing, and information research. At Battelle he is responsible for research and development planning in the fields of technical economics, marketing, and diversification analysis.

I would like to start in a slightly different vein. Imagine that you are members of a Board of Directors of the Onus Manufacturing Company in the year 1970. The president is speaking to you. Pointing to a chart on the wall, he says, "Gentlemen, when we first established our plant, in 1940, our rural location was a definite advantage. We used ten acres of the low land in the southeast corner of the property for disposing of fibrous waste material from our manufacturing operations.

"As you can see on the chart, the capital cost and operating costs of that disposal operation started out in 1940 to be very low. For 25 years,

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despite rising labor costs, we were able to keep the cost of waste disposal at a satisfactory level. By 1965, the town had grown out around us, and the odors from that landfill operation forced us to consider other ways of disposing of the residue.

"Our engineers worked out what appeared to be a good process for shredding, slurrying, and digesting the material. The effluent, of course, went into the river, up near Elbow Bend. Unfortunately, we didn't realize that three other companies had plants on the drawing boards to be located upstream from our plant. After a few years, the growth of our operation, plus outfalls from the new plants upstream, caused a fish kill during low flows in August. Consequently, we had to find some other means of disposal.

"Last year, we put in a drying operation and an incinerator that could have handled our increasing waste loads to 1960. Some of the other plants in this basin had been under pressure, and a few under direct orders, from the water-pollution board. They, like us, turned to incineration. All of these units came on-stream about the same time. When we designed our plant, our engineers were pretty sure we wouldn't run into any trouble, and we wouldn't have, I think, if conditions hadn't changed. But, in concert with the 30 other plants in this valley also incinerating material, we are in trouble again, this time with the air-pollution authorities. Now, as Fig. 1 shows, the capital and operating costs of disposal have been rising at an alarming rate. So I am proposing that we embark on a crash program of research, development, engineering, and new plant investment. Our R&D people are working on a new process that uses new raw materials and eliminates the need for disposing of any residue."

This unlikely, perhaps preposterous, but nonetheless plausible story emphasizes several points:

1. Rapidly increasing costs or other restrictions on land use are forcing consideration of alternatives for solid-waste disposal.
2. Many of these alternatives add pollution loads to water courses or to the air, and/or lead to different residue disposal problems.
3. Process modification and development must be considered, in addition to alternative disposal methods for existing waste flows.
4. Waste flows from industrial plants, households, and other sources must be considered in an overall system of regional resources and human activities.

Figure 1

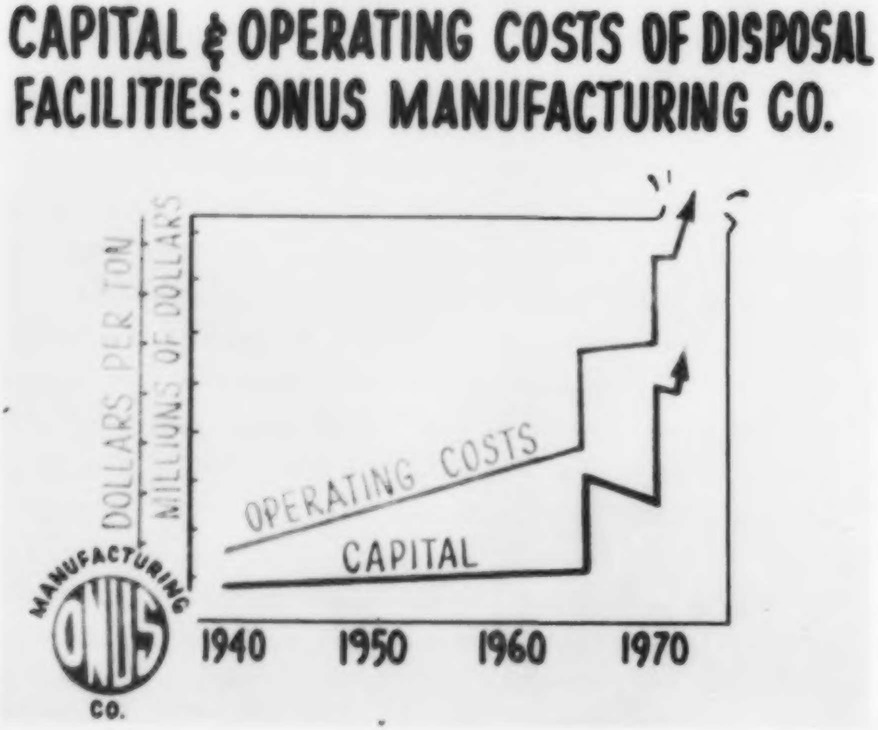
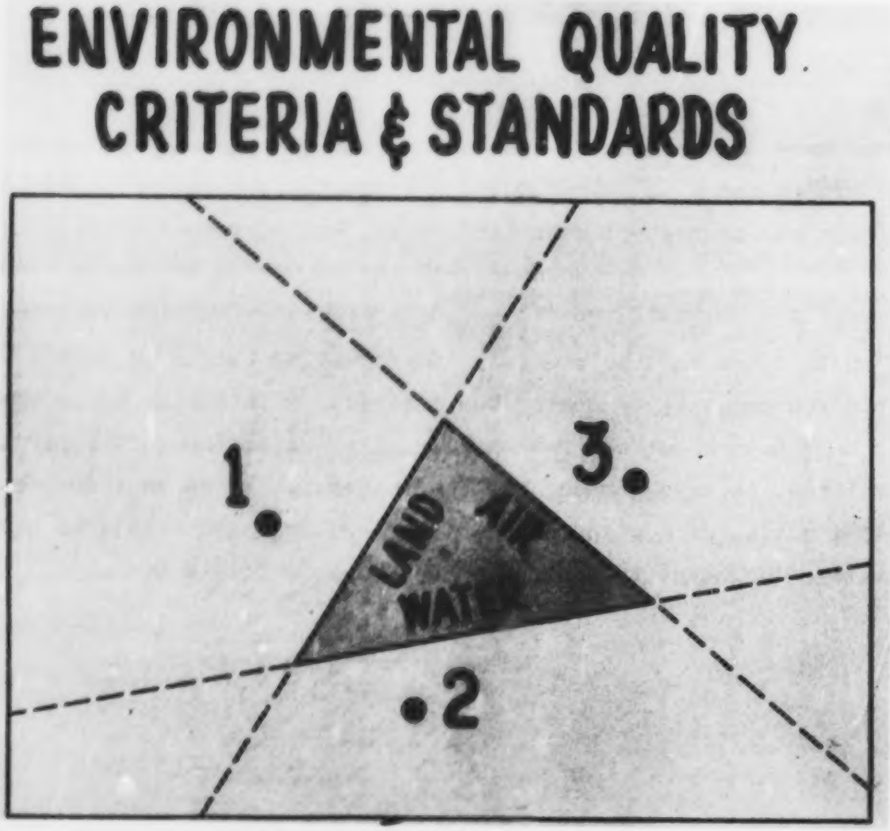


Figure 2


ENVIRONMENTAL QUALITY CRITERIA & STANDARDS
1.
2
3.
LAND
AIR
WATER

In a more subtle way, the story brings to our attention the gradual definition of technical limits on the amount of waste that can be released to a water course, to the air, or to the land. Practical engineers, county commissioners, and municipal administrators to date have had to make decisions on solid-waste disposal methods, primarily on economic bases within the ill-defined limits of "public nuisance." As landfill opportunities near the centers of cities have been exhausted, the next alternative, on a cost basis, has been selected: new landfill, transport equipment of a new kind, new incinerators, etc. Now, questions regarding air pollution and water pollution from alternative solid-waste disposal methods add to the complexity. Problems in establishing environmental-quality criteria, and the difficulties of translating them into practical, usable, everyday standards, are shaping the issues that, I think, this conference faces. They are limiting our choices; they are dictating directions for technological developments; they are confounding industrial leaders; they are the substance of an important issue of public policy.

Conceptually, the influence of environmental-quality criteria and subsequently developed standards is shown in Fig. 2. Although the present criteria are embryonic, and their translation to realistic and usable standards that would hold up in court is virtually nonexistent, we can conceptually represent the sets of standards for land, air, and water as three lines. Within the area of the triangle bounded by the sets of constraints are acceptable levels of waste release to the environment, and outside of the area are undesirable levels of pollution. Of course, my fictitous Onus Manufacturing Company found itself moving from Condition 1 to Condition 2 to Condition 3 because: 1) many solid, liquid, and gaseous wastes are technically convertible one to the other; and 2) a set of technical constraints was not clearly defined within the context of other industrial and municipal activities and waste flows, which depend on the same regional resources for their disposal.

Much has been said earlier in this conference on the interrelated nature of waste flows and the necessity for treating them as a system; except for a few comments by one or two individuals yesterday afternoon, little has been said about environmental-quality criteria and standards. Their importance, it seems to me, has been underemphasized in this meeting, and the difficulties of developing practical criteria and standards have been underestimated. We ought to look at these issues a little bit more.

First, they are important. If you and I are going to guide our technical efforts in research and development efficiently, we must have our sights set on reasonably explicit sets of criteria and standards. If desired levels of quality deviate only slightly from the characteristics of trout streams, mountain air, and virgin land, virtually all of our efforts should be devoted to exploratory research probing for new concepts and ideas, examining their possibilities. On the other hand, if desired levels are closer to the present art, our efforts should be concentrated on applied research, cost reductions, efficiencies, and system design--exploring and probing and trying to find out what the possibilities are of doing the job a little bit better in the future. The broad direction of our research and development resources should be guided by the level of the desired environmental criteria and standards.

The influence and importance of such policy objectives are often overlooked. Perhaps the best way to point this out is by analogy. In the pre-Sputnik era, military objectives dominated the area of research and development that we now know as space research: reduction in warhead size, miniaturization of guidance systems, and refinement of "small" propulsion systems. A major reorientation--almost a flip-flop in the opposite direction--to large power systems was necessary as a result of the shift in public policy relative to space objectives in the post-Sputnik era. Perhaps a reorientation is necessary here also. The direction of R&D for controlling our environment is sensitive to our policies regarding environmental-quality criteria and standards--the technical objectives of an environmental-quality control system.

The policy regarding desired levels of environmental quality is important on economic grounds too. Intuitively, the costs and benefits--public and private, tangible and intangible--that will accrue from any new system vary greatly, depending on the environmental-quality levels that we are trying to establish. Today, there is evidence to indicate that municipalities, industries--all of us--are imposing on our neighbors unnecessarily high costs by maintaining inadequate waste disposal standards. The economist calls such costs "external diseconomies." They include downstream costs incurred by users of polluted waters, maintenance and repair costs caused by particulate matter and corrosive gases in the air, and decreased value and reduced tax revenue from lands adjacent to landfill. Improved waste-treatment practices can reduce these external diseconomies. Engineering intuition tells us, however, that the costs of improvement will increase, in some cases exponentially, as we attempt to reduce these external diseconomies to zero. It can be argued, therefore, that too high a policy level could result in exorbitant system costs.

Next, environmental-quality criteria and standards are important because of the costs and confusion that will be caused by arbitrary edicts. In accordance with the Water Quality Act of 1965, by June, 1967, the states must establish water-quality criteria and standards, or the federal government will move to do so. If such standards are arbitrarily set, so that the economics of disposal tend to favor incineration or recovery of solids, we may have much larger problems than we have been discussing today. We must be prepared for a much more rapid filling of favorably located dumps. And what was thought by some to have been the "solution" to the water pollution problem will be transformed into other problems, probably without diminution.

There are difficulties in establishing practical standards. The far-reaching significance of standards, as I said, has been underemphasized. Of even greater significance to this conference, the difficulties in establishing practical standards have been underestimated.

A primary and basic difficulty is the lack of data for establishing usable criteria for air, water, and land environments. The major reason for the lack of usable standards today is not the failure of public health officials, members of pollution control boards, and their technical staffs to establish them. Rather, it is the sparseness of evidence available on the technical effects of environmental contaminants on all human activities. This lack of technical data on which to base reasonable environmental-quality standards is well summarized in the report "California Waste Management Study" by Aerojet General Corporation. What was not emphasized in that report, however, is the magnitude of the research effort needed to fill the gap. A crash program of research on a broad front might well document the direct and short-term cause-and-effect relationships; the significance of longer ecological relationships remain to be determined. Some of these haven't even been hypothesized, let alone quantified.

Even if there were sufficient technical data on which to establish usable criteria, the problems in translating them into practical standards or system-output specifications are still underestimated. The uniformity and universal applicability of environmental-quality criteria will be recognized by most of us. Regional differences, however, have an important bearing on how standards should be derived from the criteria. Relatively little thought has been given to how this can be done. Intuitively, we know that we must take into account the technical characteristics of available resources, present and future beneficial users of those resources, and the mechanisms and dynamics of economic growth within a regional economy. Regional economists have only begun to relate these technical and economic aspects to a regional economy and its growth. Yet it is an understanding of such relationships that will allow us to translate these criteria in a more meaningful way into practical standards.

Now, let's be a little more pragmatic about the issue of environmental-quality control and standards. There is wide disagreement in the bodies politic regarding such standards. For example, leading senators and congressmen, some conservationists, and outdoor enthusiasts assert that the assimilative capacity of our resources shall not be used. Extending this view, which is usually expressed relative to water resources, to air and land as well, could simplify our system-design problem. Our only course would be to design a materials-handling system from source to sink at whatever the cost. On the other hand, county commissioners, industrial development men, industrialists, and local political leaders, who have been working with local problems and trying to get bond issues passed, have quite a different view. All I'm saying here is that we can't hope for any kind of consensus on how high or how low these standards should be in any locality. One reason is that most people simply haven't looked at waste disposal as an integrated system. Therefore, they have a tendency to have parochial views of the problem and can hardly be expected to see an overall optimum balance of costs and benefits that would lead to agreement on standards.

So this brings me to still another practical problem--that of effective institutions for managing an integrated waste-handling and environmental-control system. I think all of us recognize that the present multiplicity of governmental units in most regions must be coordinated, combined, and even superseded by some kind of an institution if more than incremental progress is to be made. Can any kind of a detailed system be designed before we have a new institutional framework for on-going operations? Can a new institutional framework be established politically before we have some preliminary views on what a system or systems should encompass? Realistically, I suspect that neither can be developed too far without the other.

Finally, there are difficulties in developing realistic standards, because too little is known about the costs and benefits that may be incurred. I have already pointed out their importance from an economic point of view. Little is known as to how costs and benefits vary as a function of the level of standards that might be established. What are the costs and benefits--public and private, tangible and intangible--of the present levels, and what information is needed to estimate the costs and benefits of maintaining environmental controls at some higher level? What usable models can be developed to evaluate costs and benefits of alternative environmental quality policies in a realistic framework of a regional economy? What can be done to help formulate this policy?

A major technical effort is needed to obtain some first approximations of total waste-system cost and performance as a function of environmental-quality standards. Much information is available now; much more must be developed. The more important areas of research include:

1. Determination of the effects of environmental contaminants on all human activities--the bases for establishing criteria.
2. Characterization of all waste flows.
3. Exploration of the possibilities of beneficially modifying such waste flows, particularly industrial wastes. Many possibilities exist for recovery of material from reasonably concentrated industrial wastes at costs lower than their recovery or treatment after mixing or dilution. Other possibilities for process modification should be taken into account. For example, closed-cycle pickling of steel with HCl could virtually eliminate the disposal problems associated with waste pickle liquor or the solid residue therefrom.
4. Estimation of costs and technical performance of alternative waste-handling techniques within the present state of the art.
5. Exploration of the effectiveness of management alternatives. This is particularly applicable to managing the quality of streams and water pollution in the East, where serious low-flow conditions might be limited to only a few weeks out of a total year and discharges might be controlled in accordance with flow.
6. Preliminary experimentation with new concepts and techniques for waste treatment and estimation of costs and performance. For example, preliminary consideration might be given to the principles of separation used in minerals beneficiation for handling municipal refuse. A

preliminary experimentation with tonnage oxygen or enriched air might be undertaken with diffusers in stream beds, estuaries, pipe lines, etc. Many possibilities of a chemical and biochemical nature remain to be explored.

7. Estimation of the consequences of alternative policies on environmental quality standards in specific regions. As most of you know, Battelle has been doing some work along these lines. Our work in the Susquehanna region of Pennsylvania thus far convinces us of the need for a model or set of compatible models to simulate: 1) the physical essentials of regional resources; 2) the technical relationships of resource use and waste generation; 3) the technical aspects of waste treatment; and 4) the consequences or impacts of alternative facilities and policies on the regional economy.

With such a research program, we should be able to hypothesize a number of improved, maybe even blue-sky, waste-management systems and to make some first approximations of the costs and benefits that would accrue to a specific regional economy as a function of environmental standards. Then we will be in a position to weigh the trade-offs of cost and benefit.

The importance of and difficulties in accomplishing this essential first step should not be underestimated, nor should they be feared. It's a challenge and an opportunity for management science and solid-waste research.

COORDINATING MANAGEMENT SCIENCE WITH OTHER SOLID-WASTES RESEARCH

S. A. Hart

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Dr. Hart has been working in the agricultural area of solid-wastes management for ten years. He is a registered civil engineer, and is active in waste management activities of several technical societies.

Dr. Hart was principal investigator on the U. S. Public Health Service Research Grant which partially supported this conference. He also acted as chairman of the local arrangements committee for the meeting.

The Steering Committee felt it would be appropriate to use this penultimate spot on the program to present some additional ideas and background which might help you analyze the usefulness of the conference. However, I point out that I am speaking for myself in the following comments.

You and I--and Management Science

The first conference specifically considering solid wastes was a meeting in Chicago in December 1963, sponsored by the USPHS and APWA and

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arranged by Professor Ross McKinney. We have gone a long way since then. The federal program relating to solid wastes has given real impetus and encouragement to activity in this area, and greater things are expected in the future. For one thing, the State of California became interested in wastes management, and contracted for the Aerojet study which we heard about. That study gave timeliness and direction to this conference. However, I think it is obvious that we are not critiqueing that study, but are using it as a springboard to consider management science and our future relative to their concepts.

You and I, as engineers, lawyers, health officers, administrators, political officials, industrialists, and operators of waste services, came to this conference to see what this management science is all about, whether it can help us in our daily work, and, if so, how. I'm sure that we all learned that management science is a generic term; there are many phases and procedures, such as systems analysis, operations research, and the like. These aspects have been shown to be germane to various parts of the solid-wastes problem.

Dr. Logan pointed out that management science is a new discipline, conceived and developed during World War II, and further expanded and applied within the last decade.

Less than 5 years ago, Dr. Logan and Dr. Charnes, a mathematician, joined forces at Northwestern and began to apply the systems-analysis aspect of management-science technology to the problem of wastes. Their pioneering work has been fruitful. We are all concerned with it today, and it has produced a whole new breed of sanitary engineers. There are now such men as Lynn at Cornell, Quan at Northwestern, and Orlob in California, to mention but three. Their research is enabling governmental agencies to modify and improve present wastes practices to obtain better efficiency.

Concurrent with and similar to this effort by specially trained sanitary engineers has been the activity of planners and planning groups. They are trying to design a system for the future. Specific examples are studies of the Delaware and Potomac Rivers, and the solid-wastes studies of the Detroit and San Francisco Bay Area.

But now comes the Aerojet study, which is a combination of these two approaches. It is an argument for a plan of the future, with the thesis that systems analysis is the tool by which we can best view and choose among the alternatives that are available to us.

We have spent a good deal of the conference grappling with this idea. Certainly, one of the things that bothered me for a long time as I consulted Aerojet on their study, as I worked with the steering committee in developing this conference, and as a technological researcher in solid-wastes engineering, was: Where do I fit in? I wondered whether I would have to become an operations researcher, a critical-path methodologist, a systems analyst, and a computer expert before I could really live up to my responsibilities. At one time I even wondered whether the message of this conference would be: go get an M.S. degree in M.S.

The discussion of this morning makes the answer pretty obvious--it is neither appropriate nor necessary, it is not even desirable, for every one of us to become management scientists. Aerojet flatly states that they did not become expert lawyers, sanitary engineers, health officials, industrialists, or experts in any of the professions represented here. Aerojet acted as a specialist in one thing alone--systems analysis. They assembled consultants in the other fields as necessary.

This morning our speakers discussed the specific areas of concern in conducting a comprehensive systems study. They pointed out the need to know the intricacies of special areas as an overall program is devised. Such expertise in the various disciplines can be accomplished only as we have true specialists in these fields.

There is a beautiful analogy to all this that brings this idea into sharp focus. All baseball players know how to throw the ball, but a baseball team has just one pitcher. The other eight men on the team are specialists in other aspects of the game. So too with us. This conference was designed to make us appreciative and knowledgable about management science, but it was not intended to make us experts in the field. You and I are needed in our respective areas of capability; we cannot be all things to all men, and we should not try. The solution to the solid-wastes problem is going to take team effort.

Without detracting one whit from the important contribution that the systems-analysis branch of management science has made and will continue to make in the area of solid-wastes progress, we ought to recognize what the limitations of that contribution will be. Such effort will enable us to: a) choose better between alternate present systems; b) improve the efficiency of present operations; and c) better anticipate the future--based on our present and proposed capabilities.

This last will enable us to appreciate what areas are most fruitful for research and development. However, management science in itself is not the tool by which this research and development will be conducted. That is, biological principles of wastes degradation, better designs of garbage trucks, preventive medical research related to wastes, and the changes in laws, attitudes, and administration that will upgrade our environment are the province of professionals in these specific fields. These latter obligations are ours, as specialists in these areas.

So, to sum up this first part of my talk in one phrase: management science does not render you and me obsolete.

Where we fit in

There is an important corollary to the question of where we fit in with this technique of management science. It is to consider how we can perform our individual activities in better coordination and thus find solutions to the solid-wastes problem more quickly. For instance, for a number of years I have been working in the field of agricultural sanitation--that's a fancy and sophisticated name for manure handling. I--and the farmers--thought the problem was primarily one of managing the manure so that it did not create a nuisance and public health hazard, so that the local health official would not be blowing the whistle on agriculture. Looking at it in broader perspectiv now, I can see that the farmer's particular problem is only a small part of the whole. My future effort in helping him should consider not only his immediate problem but that of the community as a whole, and the effect of today's solutions on tomorrow's environment. I do not thereby become a management scientist, but I recognize the fact that the whole is composed of many parts, and that the part on which I am working must somehow be related to the whole.

Before I begin to sound as if I had stars in my eyes, let me assure you that I am not going to talk of Utopia. I recognize full well that everyone will, and probably must, look after himself. So I am sure that my farmer friend will not voluntarily install an elaborate and expensive manure stabilization machine--whatever that might be--just because he wants to reduce agriculture's insult to the environment. Neither can I conceive that my wife or yours will independently pay an extra cent a can for Product X, just because the manufacturer went an extra mile in waste disposal. That is just not the way the world is. Yet, we learned yesterday that the social cost of not going that extra mile--of not improving our environment by better wastes management practices--actually costs us three or four times the "out-of-pocket cost" we are so reluctant to spend.

We thus have our chore set out for us. We must make traveling that extra mile ever more economical, more beneficial, and more desirable.

The key question we must ask and answer is: How can you and I work to this goal of a better environment at an acceptable cost? Regrettably, I do not have any "key" answers. I cannot tell the refuse industry to be more concerned with esthetics and sanitation than with making financial ends meet; I cannot tell the consulting engineer to design an ultimate system, to compost and salvage everything possible just because reclamation is good. I cannot tell you how to make your personal activities any more productive toward our long-term goal of a better environment through better management of our wastes.

However, this is basically a research conference, albeit research of a different kind. It may sometimes happen that a research conference is attended by researchers just to tell about their own work and pay little attention to other speakers. This conference is different in that you are the researchers, and we speakers are trying to get across a concept which, hopefully, you can apply. So, it seems appropriate that I speak to the idea of what is being done, and what might be done in solid-wastes research that correlates with this management-science approach. Perhaps you can see the analogous situation, of relating management science and your activity.

Professor McGauhey, whose fine speech was read for him, has been in the vanguard in seeing the need to combine technological research and management science studies. He has therefore assembled a team of University of California researchers to work on this two-part study. Faculty from the Department of Urban and Regional Design--planners, if you will--are going to use systems analysis to suggest and evaluate an improved solid-wastes disposal program for the San Francisco Bay Area. They are going to examine the political and social implications of filling the bay with garbage, and estimate the cost and acceptability of alternate procedures. Although they will be specific in using the San Francisco Bay for their research, they are sure that the logic and procedures they use will be applicable to any other community. But, incidentally, two percent of this country's population lives in this San Francisco Bay area, and this is a substantial population upon which this research can immediately impinge.

Concurrently but independently, the Industrial and the Traffic-Transportation groups from the College of Engineering are going to use this same San Francisco Bay model for a comprehensive analysis of costs of hauling and of transfer and haul to alternative landfill sites in the outlying and hilly areas of this geographic area. I think we can all see that these two management-science studies are compatible with each other and, additionally, suggest fruitful areas for technological research. The second part of the research effort--on technological approaches--is also going to be carried on by various groups within the University. I, personally, will be working on composting for the purpose of reducing the volume of waste going into a landfill. Hopefully, this will use volume not only less rapidly but also with less settling of the completed fill. Dr. Brink, of Forestry, is considering wet pyrolization of organic wastes as a method of partial reclamation and volume reduction prior to insertion in landfills. And Professor McGauhey has his own research organization, the SERL (Sanitary Engineering Research Laboratory) of the University, committed to research on slurry transport of solid wastes in pipelines, and its subsequent processing--probably in conjunction with sludge digestion, drying, or other treatment. When and if one of these technological research avenues is proven out, it will be possible to crank this back into the management-science study, and thus advance the day of better environment for the San Francisco Bay area.

Everybody Should Get in the Act

We are sure that the two management-science studies will indicate that there should be improvement in the jurisdictions responsible for wastes management, that there are public health aspects of solid-wastes handling that need to be evaluated, that there are present sources of waste production which can be and will have to be modified by present engineering and industrial know-how. Thus, all of us have an opportunity to contribute to improvement of our environment as management-science studies more accurately pinpoint areas for effective action.

I do not intend to blow the horn only for University of California research. There are already a number of most promising research studies being conducted by universities and other organizations around the country. Their results, as they become available and proven, will certainly be the raw material for management-science studies of waste management for all our municipalities.

In summary then, I personally can see that management science can assist us in making wiser decisions regarding present solid-wastes management; it can indicate areas for fruitful activity on the part of all of us specialists; and, as new developments are made available, management science can account for them in helping us make even better decisions toward a better environment. I am appreciative of the contribution that management science can make; although I won't become a systems analyst because of it, I will surely try to work well with those who are. Perhaps you will too.

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THE FUTURE

Frank M. Stead

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For twenty of his twenty-two years of State service, Mr. Stead has been the dynamic leader of the Division of Environmental Sanitation. He is a registered civil engineer, member of innumerable state government task forces, and active worker in numerous technical societies.

I feel a little, at this point, like the extra help that the dime store hires around Christmas, when people come in to buy packages of every peculiar shape. The poor gal is trying to wrap string around the package when, just at the last round, the whole thing flies apart and goes all over the floor. This may happen to this wrap-up of the conference.

I have taken the trouble to sample a little of the opinion of this audience about this conference in various ways, and the best way I could think of was to eavesdrop. At a conference of this sort, one can ordinarily plot opinions about the conference on a curve of normal probability. Most

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of them, about 80%, amount to polite approbation of the way things went. Then, about 10% of the people are constitutionally impossible to please, and another 10% are extravagant in their praise. As measured by my sampling, however, the profile of opinion on this conference isn't a curve of normal probability at all. It's a bimodal curve--not much of the conventional approbation. Instead, about 40% of you are completely at sea as to what in the world the Steering Committee had in mind, and another 40% can't leave it alone. You don't know quite what it is yet, but you sense that there is something tremendously viable here, that there is something viable here in this room. Another proof--a real proof--that this is not the curve of normal distribution, is that at 3:15 p.m. you are still here. Three hundred and fifty people came here from all over the United States, conned on by the magic of Sam Hart's couplets at the bottom of this program, but the majority of you are still here, and this is atypical. We've got something here, and I hope I don't louse it up.

Let me tell you what the Steering Committee had in mind. The order of this program and the appearance of the speakers were carefully conceived. It started out with Mr. Paul Ward's statement that we are on a collision course with disaster--10 years from now, 20 years from now, give or take a little. In other words, our present concepts of waste management for the future must be considered obsolete. That was a shock awakener. That was to bring you wide awake and on the edge of your seat. And then we had Mr. Hickey describe what we thought was a dramatic example of an area about the size of the one brilliantly described by Mr. Frank Bowerman, but not under the management of a few large organizations; this area is under the management of 67 different political governing bodies in an area which had been thrown suddenly into a state of excitement by the act of the Bay Area Conservation Development Commission--shutting off, suddenly, 67% of the landfill capacity then in sight. So we thought that if Mr. Ward didn't awake you, Mr. Hickey would. There is a problem--a dramatic problem--being faced as we look a few decades into the future.

Then we had three speakers describe a new approach. One was to give you the theory of the new approach; another to give the feel of it, the bedside manner of it, so to speak; and then, finally, the curtains were to be drawn back so you could see a model of the year 2000. But it didn't quite come off. Perhaps the time was too short, perhaps lots of things; but I believe that at the end of the session yesterday afternoon, you weren't quite buying this. You were saying to yourself: There is nothing new to this. Shucks, engineers have always optimized things, they have always made these kinds of comparisons.

And then, on the second day, which is today, there was a rapid-fire succession of speakers coming from all points of view of the compass. Just as the composition of this audience is heterogeneous, the speakers would approach this shiny new model and say why it wouldn't work or would work, or say anything they wanted, but not leave it alone. That didn't quite happen today either. I think you saw the day in the first six comments this morning. Primarily, the points of view of six men from different backgrounds or experience were fascinating, but that is not what was in the original scheme. As it gradually drew to a conclusion and the cycle closed for the two days in symmetry beautiful to behold, we were to have brought you to this point so goldarn fired up that you would really be ready to go out and bring in the new age.

But, perhaps, it is just as well that it happened as it did, because one thing that you do see is an audience that is thoughtful, deliberate, puzzling, and wrestling with a situation. I would like to tell you where I think we are. What I think is ahead in this field of waste management, and I don't care by what name you call it, are five new concepts or old concepts, but five concepts different from the ones that now drive the program, that must drive and shape the program. And I think we must achieve a changeover from where we are to each of these five concepts.

The first one, and its works keep getting in our way, is that our friends from the aerospace industry say we must get a concept of output orientation rather than input orientation, which is saying we must think about the environmental consequence and not the waste itself. And what does this mean?

To me it means that there are two stages in waste management just as certain classic events in the history of this world have divided all history into two parts before and after. I think when one leaves one of these phases and enters the other, it is just such a classic changeover. The first stage is the management of wastes within the assimilative capacity of the environmental resource. We gained our first experience on this in the field of water, and, particularly with the discharge of unstable organic wastes, we realize that in the oxygen resource of streams we had an assimilative capacity of considerable magnitude and considerable economic worth. Most of the textbooks written 20 years ago have assumed that we could always operate within the assimilative capacity of water, the assimilative-capacity concept. Certainly, going by it and reducing the input stream of waste somewhat, we could always operate on this concept. But, when California, for example, endorsed the California Water Plan, in which two-thirds of the water users of the State are served water through a system of man-made aqueducts and water stored in man-made impoundments, the system of assimilative capacity was gone. It was gone before that, with respect to mineral wastes. When you reach the assimilative-capacity limit and change over into the next era, you are in the era of steady-state relationships, and you must design a system that is good not for 10 years, not for 100 years, but for a thousand years or even longer. A steady-state relationship that can go on without a continual rise in mineral content, a continual rate of change; an actual equilibrium. So we have reached that steady state with respect to water in California and in many others parts of the country. We have gone past it and haven't realized it elsewhere.

In the field of air sanitation, this assimilative capacity was a very unspectacular thing. Whereas some atmospheric contaminants like carbon monoxide can be assimilated into the atmosphere up to, let's say, 20 parts per million, and none being present naturally, this is a huge capacity. The ones that participate in the photochemical reaction get us into trouble at a fraction of one part per million. The assimilative capacity of air is very, very insignificant, and one must start almost at the outset, at least when dealing with photochemical air pollution, on a steady-state concept, which means, inevitably, a mandate to drive the sources to an extremely low level even though this means technological changes for which we are by no means ready--that is, a mandate with a timetable.

Now we come to the steady-state concept in solid wastes. The assimilative capacity of the fillable depressions, and in many of the geographical areas this assimilative capacity is almost reached. I'm frank to tell you that I was a little troubled by Mr. Bowerman's presentation. The main reason was that it was so brilliant. I'm apprehensive lest his brilliant presentation gloss over the stark, rigid, inevitable end-of-the-road reality on assimilative capacity for solid wastes that I believe exists. The factor mitigating this feeling I'll come to later; and if Frank thinks this is a dirty trick when I get through, it is.

What's the second of the major concepts and the major changeovers? Well, it's the one that has been batted back and forth here like a badminton shuttlecock. The concept is that air, land, and water resources are a single interlocked system with flux back and forth across the boundaries, so that the waste burden, for example, may be driven in any direction; and, if we have independent, unrelated empires of operation, we can really louse each other up.

What does it mean if you accept the validity of this, and I don't think all of you do; but, when you do or if you do, what is the consequence? The consequence is that we must make a changeover into a consolidation of two things relating to the handling of solid, liquid, and gaseous wastes, or management of air, land, and water, as the case might be. You must have a consolidation of planning. This must be a single endeavor, a single venture, and the biggest change, after all, of what I am talking about. If you are concerned over a loss of sovereignty or jurisdiction in the waste field, I'll tell you what to worry about. It is in the emergence of planning as the key, as the very heart of the solution to this problem. There must be a merging of the planning on air, land, and water management.

Secondly, there must be a merging somehow to develop a usable package of actual management of policy. And with respect to execution, this can take place in each of the 3 subsystems as long as there is this degree of consolidation of the policy at the management level, at the decision-making level, and at the schematic level.

The third question, and one that wasn't talked of very much today, is the size of the system. Here again, Mr. Bowerman's illustration, the tremendous appeal of it, and the tremendous success of it which he presented, is attributable in large part to the fact that his system of control is geographically big enough to envelop all the parties at interest, whereas, in contradistinction to this, the Bay Area is chopped up into a jigsaw of 1000 pieces. But how do we achieve the absolute essential mandate of operation in terms of a system big enough to include all of the effects of the actions that are taken, all the beneficiaries and all the victims, all those who benefit and all those who pay the cost? It calls for something that was discussed here today, something new in the way of intergovernmental arrangements, not necessarily intergovernmental consolidations, but intergovernmental arrangements in which the only sovereignty that is surrendered is a portion of the sovereignty at the conceptual decision-making stage, not at the management and execution stage. But when one does this and when one expands this geographical size and consolidates this conceptual policy-making, you have got to take another step--or anarchy results. That step is equitable distribution of the costs in terms of the benefits. Those of you in California who want to see this one hammered out, stick around until the final stages of the Bay Delta Study are entered into, and you'll see where the real issue comes starkly to light.

The fourth point was talked about a good deal, and this is the question of standards of environmental quality, but I don't believe many really usable concepts or ideas emerged from the discussion. I would merely like to make two points on this. The first is that waste management, or environmental resource management, is no longer primarily a public health business. It is shot through with concerns to the public health, but if the solution is to be half-way respectable, you've got to go beyond this. You are then dealing in two other realms, with one of which we have had some experience--in fact, long experience. This is the field of nuisance prevention. Our very concepts of nuisance go clear back to our heritage in common law from our Anglo-Saxon forebears, and the concept of the equities and the definition of public nuisance have not changed in five centuries. But the new realm, the new concern, the new level at which we are operating and setting an environmental standard are in this nasty field called esthetics--and if there ever was a snarl word, it is that. But let me tell you that esthetics are really the stuff of living. They are, if you think about it a bit, the major reason for living; namely, enjoyment of life. We therefore must have in our changeover a new definition of the scope of the powers of government which have been set forth for the serving of human health and human welfare; we must redefine this so that we make very sure what we're talking about with respect to welfare, and this is a level of maximum enjoyment of the environmental resources. We bring it into usability by translating it into a coinage that can be used in a cost-benefit analysis, and until a better one comes along, that's dollars.

There is no time in this discourse to develop this idea, but just let me tell you about it, so that if you're interested you can think about it too, and if you think I'm wrong, tell me. I've worked a good deal on this thing to decide in California what is the probable cost in the next 10 years to regain environmental quality where we have lost it and to maintain it where we still have it--optimum levels for air, land, and water. On land, I mean an orderly, pleasing arrangement. The changeovers that need to be made add up in my gross estimation to about $1.5 billion a year over what we are now spending. This comes out to about 25¢ per capita per day, and I will wager that I could easily convince you that every man, woman, and child in California today is spending on the average in excess of $1 for esthetics in 3 small subsystems: the food system, the housing system, the transport system. Not for utility, but for esthetics. So that as little as 25¢ added to this $1 per capita per day would underwrite the esthetics of the big system. What I'm trying to say is that you've got to get this down into terms that people can understand and that are mathematically manipulatable. I, for one, am perfectly confident that this may be done on a go-no-go basis; in other words, I'll defend that it is worth at least 25¢ a day, I'll defend that it is worth at least 50¢ a day. I'm not prepared to say where this pendulum will come to rest, because research must first enter in, but I believe that intuition, once the choice is made and translated into dollars and cents, will serve us for the 10 years that it takes for the social scientist, or the behavioral scientist, to come up with an objective proof of this point.

Now the final point here in our conceptual need is to accept the principle that we are seeking the best solution for the total population. This, again, is asserted with the understanding that the distribution of costs will be made on the basis of equities. Here is the reason we brought in the Aerojet report. We thought it would be interesting to you to see that there is a capability highly developed with respect to its analytical and mathematical composition for handling a variety of factors, almost innumerable factors and relationships. And here is a group prepared to bring this genie to our aid, not to take our job away from us--with an "if": if we collectively have the imagination and "savvy" to make this thing work today where it has never yet worked, not in the weaponry regime of the aerospace industry where all decision-making is consolidated, where there is already a centralization of this decision-making power, but in the political system that you and I know. The question we were going to leave you with and the question I now leave you with is: can this technique survive in our political system?

A last note that I want to strike is this: it's late. Four things in the changeover (let's work them backwards, the last one first): a change in our construction, in our financing, in our technology, and in our concepts for managing of wastes. What's the lead time once we have the design--five years, 10 years? Probably 10. Before that begins, there must come the creation of a management decision-making planning system, this intergovernmental arrangement which I spoke of. How long would that take? Legislatures meet every two years; something as tough as this would take two tries at the legislature--at least 4 years--where you do not now have it. Now, we've got 14 years. Before that can come, there must come the concept. We were naive enough to think perhaps we might launch this concept in two days. Let's give it two years. Paul Ward said, "We are on a collision course with disaster sixteen years hence." This adds up to 16 years. Let's go.

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